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In this issue

Audi's Electro-Mechanical Parking Brake System

With contemporary vehicles, as it is with every facet of modern life, technology makes changes and advances rapidly. Constantly evolving technology will continue to shape and change the way we understand and service vehicles now and into the future. Safety systems, however, are still the primary focus, and it is critical to understand how to properly service these sophisticated systems, with brakes being the single most important safety feature of a vehicle. And Audi, often ahead of the curve, is a leader here.

In most vehicles the emergency brake system has not changed much since the days of the first cars. It is typically a simple pawl and ratchet design attached to cables that run to the parking shoes at the rear wheels. Even now, more than a hundred years later, most vehicles still rely on a mechanical lever to control the rear brakes, or parking shoes.

This is beginning to change as technology advances and electronics control more vehicle systems. Braking systems already use electronic controls, so it is logical for the parking brake system to follow suit. Many high-end manufacturers have begun integrating electronic parking brake systems into their cars and, eventually, as the technology becomes less expensive, electronic parking brakes may become standard on every vehicle on the road.

Removing the emergency brake handle clears up a lot of space and lends itself to a sleeker design.

Audi, always striving to stay ahead of the competition with innovations, has taken advantage of the electro-mechanical parking brake (EPB) system on many of their vehicles. This system offers multiple advantages over a basic mechanical brake design.

- Functionality and safety. By communicating over controller area networks (CAN), the electronic parking brake system carries out multiple jobs. Primarily, when parking the vehicle, it is employed by simply pressing the button on the dash, or center console, to lock the rear wheels and prevent the vehicle from moving.

The rear brake actuators are the workhorses of the electro-mechanical parking brake system. Audi has integrated electric motors attached to a multi-stage gear assembly to securely lock the rear wheels. As robust as they are, these electronic actuators do fail from time to time. Most often, the electric drive motors wear out, position sensors fail, or they become damaged by water.

If an actuator fails, it may prevent you from removing the brake caliper during replacement. In these cases, the actuator must be removed from the brake caliper. Once removed, manually turning the exposed drive gear on the caliper will allow the caliper piston to be fully compressed. This is only used in cases where the caliper, or actuator, is damaged, since damage also may occur during manual removal.

In most cases Audi does not sell the actuator separately, and an entire caliper assembly must be purchased. However, the actuator itself is removable and can be replaced. Aftermarket

options exist, and often are produced by the same manufacturers that made the OE parts.

The EPB system relies on relatively few sensors and modules for operation. The brain of the EPB is the control module, which resides in the center console area. This communicates all functions for the parking brake system. It also works in conjunction with the antilock braking system (ABS) control unit via CAN bus communication. The control unit houses multiple sensors: lateral acceleration, longitudinal, and a yaw rate sensor. These sensors are used for both stability control and ABS systems as well as parking brake EPB functions.

Another feature of Audi's electronic parking brake is the hill hold function. This is available on both automatic and manual transmission vehicles. This system integrates a clutch position switch for manual transmission cars. The clutch position switch is extremely important for multiple vehicle systems: vehicle interlock/starting; cruise control; and by sending a pulse width modulated PWM signal to the EPB, the position of the clutch pedal is known. This allows the control unit to determine the proper release point of the rear brakes to ease in hill starting. Acceleration sensors built into the parking brake control unit assist the system in making the determination. This system also connects to the ABS control unit for added stability and safety.

The actuator is a simple bolt on design attached to a modified brake caliper.

Often even looking from the inside it can be difficult to gauge brake pad thickness.

- Cleaner interior layout. One of the first things people notice when getting into an Audi is how luxurious the interior of the vehicle is. By removing the emergency brake handle and replacing it with a button, this allows Audi to create a more sophisticated interior design and layout. This is particularly helpful when many of the accessories, such as the MMI controls, climate control, etc., reside on the center console.

Service

Brake pad wear is unavoidable and can be accelerated, particularly with heavier, more powerful cars. Although front brakes tend to wear out quicker, as they have more weight over them, the rear brakes should not be ignored. Typical brake pad life ranges from 40–60K miles. This varies, of course, depending on driving characteristics and geographical location. Often, vehicles that are parked outside for long periods suffer corrosion and rust buildup. This can result in a warped brake rotor, or in a worst case scenario, a delaminated brake pad or seized caliper. Proper inspection techniques are critical.

Brakes should be inspected at every service without fail. During brake inspection, it is critical to observe both the outboard and inboard pads on both sides of the vehicle, front and back. Often, the inner pad wears more quickly, and an outer brake pad that looks OK at 5mm thickness may have a 2–3mm inboard pad thickness. Often, rear brakes do not have wear sensors, so inspection is necessary here to avoid metal on metal brakes.

Inner brake pad thickness may be difficult to see without using an inspection mirror. In certain cases, with limited visibility through the wheel, removal may be necessary to accurately assess pad thickness. Taking a few additional moments to inspect further will ensure a safe, happy customer and a thorough technician selling a brake job.

European vehicles, including Audi, tend to have a softer metal for brake rotors. The softer metal helps to provide a "stickier"

material for the brake pads to adhere to, resulting in a shorter stopping distance and better brake feel. The downside of this is that the rotors wear more quickly.

When rotors wear, a lip is created on the outer, and sometimes inner, edge where the brake pad rides. This lip can cause uneven pad wear, and even noise and vibration. It's important to measure thickness and know discard limits, and to visually inspect the rotor surfaces. Audi does not recommend machining brake rotors during service. By matching new brake pads with new rotors, the best possible brake performance can be ensured.

Always use original equipment manufacturer (OE) grade pads and rotors. Less expensive off-brand pads and rotors are often made from cheap materials and do not stand the test of time. Inexpensive rotors are usually made from much harder materials and will be noisy and offer poor stopping performance. Audi vehicles are made to be driven hard, and thus require better parts. Don't be cheap! Nobody likes a comeback.

Critical Tools

Once you have determined that a vehicle needs rear brake replacement, a few critical tools will be needed. Most importantly, proper communications/scanning equipment is required. Audi's dealer-level VAS software or Vag-com are recommended for reliable scanning. Without properly actuating the rear calipers during the renewal process, damage can occur to the brake caliper. Trying to compress the rear calipers without using scan equipment will absolutely result in damage as well.

A battery charger is also required for the brake renewal process. Because you must remain connected to the vehicle while doing the repair process, battery voltage must be regulated. The EPB system measures the clamping force required to lock the wheels and requires a constant voltage supply to maintain proper operation. The electro-mechanical parking brake module, or EPB, is sensitive to voltage fluctuations and causes problems if battery voltage drops during the process.

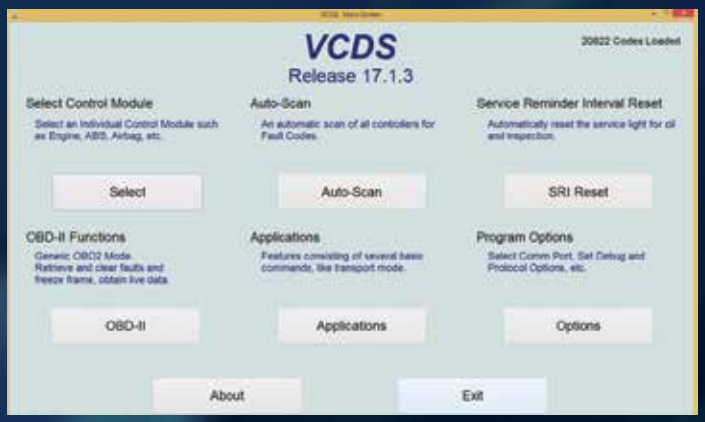
Module failure is known to occur if low voltage is present during the process. Conversely, overcharging the battery during EPB service can damage many systems. If your charger has a programming setting, this is ideal. A constant 12.8–14.2 battery voltage is perfect for scanning, programming, etc.

It is not recommended to place charger leads directly onto the battery terminals on many newer Audi models. A battery management module is used to control power to many vehicle systems. Without proper charger lead placement, modules may not be functional. When placing the charging leads on the vehicle, always use the proper charging lugs. These may be located under the hood, or on some models in the trunk of the vehicle.

Once you are connected to the vehicle with the scanner and battery charger, work can begin on rear brake replacement.

The EPB system must be put in "service mode" to allow the caliper pistons to be pushed in. Trying to push in the pistons manually without activating the system properly will result in caliper damage.

With the scanner open, select "group 53-parking brake module." Once in the module, select "04-basic settings" menu. Basic settings contain multiple actuations and settings changes depending on the vehicle. If using the VAG-com software, there is a drop-down menu visible.



Any time you are scanning a vehicle, you must use a charger properly.

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Selecting "Start lining change mode" spins the drive motors fully back into the caliper housings. The motor actuation is audible as well as current values on the scanner. It's important to wait up to 30 seconds for this process to fully complete. The current value for left and right calipers should both be at zero or very close to zero. You can now exit the scanner and turn the vehicle key to the off position to continue the brake replacement process.

The caliper piston will not appear to have moved at this point. However it is ready to be pushed in like a normal front brake caliper. The inner spindle drive gear has been compressed; however that may not be obvious. Do not attempt to twist in the rear calipers. They have pistons that appear to be keyed for rotating in. To emphasize, DO NOT twist these calipers. Damage will occur.

If replacing the rear rotors, it's necessary to remove the caliper carriers. VAG vehicles use larger-size triple square sockets to secure the carriers. These are not a standard socket that many technicians have lying around. Be sure to have some on hand before selling a rear brake job. The most common sizes used on Audi vehicles are 14mm 12pt, and 16mm 12pt.

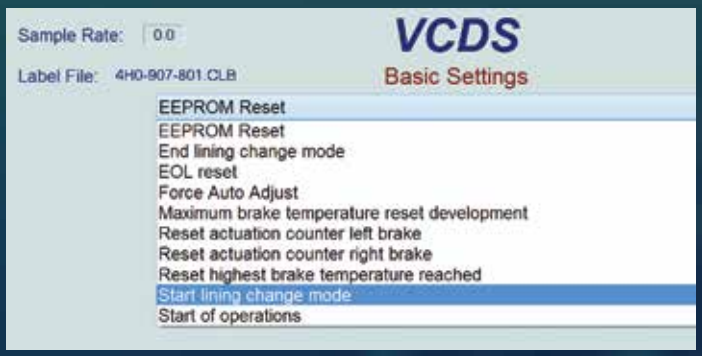
When replacing the pads, it's important to clean and lightly lubricate the pad carriers. A high-pressure lubricant on the carriers helps to keep the pads from shifting and vibrating. This ensures a smooth moving and rattle/squeak-free brake job. This step is often overlooked by rushing technicians and can potentially cause a comeback if overlooked.

Now that the pads and rotors have been replaced, the rear parking brake system needs to be actuated again. Press on the brake pedal a few times to seat the brake pistons, and insert the key in the ignition. Connect the scanner selecting group 53. Enter basic settings, and select "End lining change mode" under the pull down basic settings menu.

This actuates the parking brake motors on both calipers so the system can recognize its end stops. Allow the system to run the actuation. This may take up to 30 seconds to complete on Audi vehicles. Once this actuation is complete, you may disconnect the scanner. It is always wise to test the system again by actuating the parking brake button. If everything works properly, you are done!

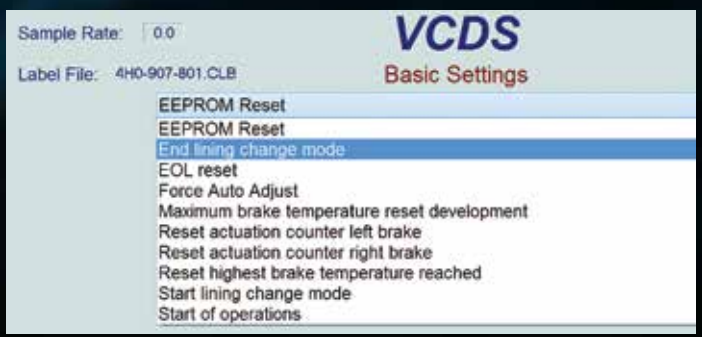
The EPB system may seem complicated and difficult to work with. But the system is actually quite streamlined. As long as proper procedures are followed during the repair process, brake renewal takes only a little longer to complete.

Audi has strived to make the EPB system safe and trouble free. For the most part, they have succeeded. It is up to the technician to stay up to date on these systems to properly and safely service them. ■



Although they may appear to twist in, these pistons do not.

Without the correct tools for the job, you will be stuck.



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What to do when the pistons "just ain't fitting"...

Comparison of stock connecting rod to its stronger, forged, aftermarket component. Note that the stock rod is narrower towards the base of the I-beam. Internal clearances must be carefully inspected and material relieved as necessary if interference exists.

Everyone knows that Porsche engines are built to a very high level of precision. Factory engineers go to great lengths to specify materials, parts configurations, compatibility, and precise specifications in order to achieve the performance and durability expected from these cars.

This is especially important when faced with the task of rebuilding one of these engines when overhaul is needed, and even more so when the vehicle is one of the very high performance twin turbocharged powerplants like that found in the limited-production 993 models.

Building an engine back to factory specifications is relatively easy because much of the thinking has been done for you. You need only to look up the specifications, measure the parts and assemble things carefully. There are significantly more complications that can arise if you are using high performance aftermarket components.

True enough, in many cases some of these are better and stronger than what the factory delivered but they don't always play well with all the other components that were engineered from the factory. Connecting rod interference with engine case internals, different bearing clearances, and concern about piston-to-valve clearances are just a few examples of non-stock parts that need to be checked during assembly.

It is the engine builder's task to assure that all the parts are going to work in concert with each other and nothing bad happens when the

key is turned. It is not uncommon for an engine build to be put on hold if additional machining becomes necessary or a different part needs to be sourced. This becomes just a normal part of the process.

The choice of high-quality replacement parts is critical. But, in the end, the responsibility for the finished engine lies with the engine builder. Not the machine shop. Not the parts manufacturer. The engine builder.

It is up to the engine builder to examine, measure fit, check and re-check clearances and other critical specifications to assure that they are correct. In some cases, replacement parts may differ from the OE components, in design, construction, dimensions, or materials. In such cases it is incumbent on the engine builder to know the complete nature of the parts being installed, and to assemble the engine accordingly.

Always follow the manufacturer's procedures for measuring any engine component. This cylinder is being assessed for reuse, and should be measured at several different points for roundness and taper.

In the case of Porsche engine overhauls, it is common to purchase pistons, rings, and cylinder liners as a package. Doing so will assure complete compatibility of the various parts. Even so, it is up to the engine builder to measure and confirm all clearances and other specifications since the final product is on him (you....).

Some replacement pistons may be made of a different material from those used when the engine was first assembled. In such cases, coefficients of thermal expansion may be different from the OE pistons, the liners may have different metallurgy and, for these and other reasons, dimensions and operating clearances may differ from those specified in the OE service manuals. You may find the need for different piston ring end gaps and side clearances, the ovality of the new pistons may be different from OE pistons, and piston-to-bore clearances may be different from the factory specifications.

It is important to buy replacement parts that you're familiar with and have confidence in. Depending on the supplier you use, for example, you may find replacement pistons, rings, and cylinder liners packaged separately. Or you may find that the rings are pre-fitted to the pistons, and the pistons are packaged with their respective liners. This is certainly the preferred method, since it implies that the rings are a proper fit to the pistons, have the correct depth and side clearances, and are sized to the cylinder liner they're packaged with. This includes having appropriate piston ring end gap within the cylinder. It is still the responsibility of the engine builder to double-check all of these critical dimensions, but having them pre-matched certainly inspires confidence that the clearances will be correct.

Best practice dictates that the piston to cylinder clearances are confirmed by measuring the piston dimension, at the point specified by the manufacturer, and compared to the dimension of the cylinder bore.

Being familiar with an engine family is surely a plus, but it can also lead to complacency. Consider this scenario. You know from experience that the factory spec for piston-to-bore clearance for factory pistons in the Porsche engine family is 0.004. Yet when double-checking pistons and liners in hand, you find clearance of just 0.0015. And the mystery deepens when you find exactly the same clearance on all six pistons and their cylinders.

Double-checking your service data, you re-confirm that 0.004 is indeed the factory spec. So why would new pistons and liners have much tighter clearances, that are consistent across the board?

The answer lies in the construction of the pistons.

Pistons for these engines may be cast, forged, or hypereutectic. Now we all know what cast and forged pistons are. And we know that they can have different rates of thermal expansion. So assembly clearances may vary depending on the construction and metallurgy of the pistons.

Forged pistons are the most expensive option when building an engine due to material and machining costs. A forged piston starts life as a billet which has been subjected to extreme pressure giving the material higher ductile strength, allowing it to handle the loads from high compression and RPMs. Far more machining is required, however, because a billet's shape is much different from the end product when compared to a casting. A lot more material winds up on the floor in the form of aluminum chips in the manufacture of forged pistons.

Cast pistons, on the other hand, are much cheaper to make. Molten alloy is poured into a mold that rather closely resembles the end product. Less machining is required than that of its billet forged counterpart. The ductility is lower due to the fact that they were not formed under pressure and the alloy is not as dense, so cast pistons just aren't as strong.

Know your measuring tools intimately and periodically check them for accuracy. Any precision measuring device is only as good as its user!

However a third alternative is hypereutectic pistons, and these pistons typically require clearances that are much different from those for cast or forged pistons.

With hypereutectic pistons, silicon is added to aluminum alloy to help with scuffing and to control thermal expansion. The word eutectic refers to the proportion of silicon in the aluminum alloy that makes up a piston. When silicon is added to aluminum in its molten state, the aluminum can only absorb a certain amount of silicon and remain soluble.

Cylinder head studs have been designed and redesigned to the point where there are now many good options. Compare material, strength and ease of use when considering something that is going to hold up better than original components. The latest factory "fully threaded" stud comes with a thread locking compound already applied. Be certain to use a high strength thread locking compound when installing aftermarket studs.

The highest amount of silicon that can be added to aluminum and remain soluble is about12% of the alloy, and this is referred to as its eutectic state. If more silicon is pushed into the mix, it remains as a crystal structure which is dispersed evenly throughout the aluminum alloy. This now becomes a "hypereutectic" alloy, and its benefits are greater than its eutectic counterpart as expansion is much more limited and it is stronger.

As with most things in life, there are trade-offs. Here the downside is that the pistons become slightly more brittle as additional silicon is added, but this is a small trade off given the added overall strength. Hypereutectic pistons typically contain anywhere from 16% to 18% silicon. The cost of hypereutectic pistons falls in between that of forged and cast pistons, so they offer an excellent value when price is a consideration.

Performance and strength are important in piston construction, but hypereutectic pistons offer more advantages beyond their use in performance applications. Automotive engineers have been constantly making refinements to internal combustion engines in an effort to achieve more with less. The use of hypereutectic pistons helps this effort in terms of both emissions and wear.

Most of us are aware of basic piston construction and that there is a significant gap between the cylinder wall and the top of the piston above the upper compression ring. This gap is known as a "quench zone," or an area where unburned fuel can hide. Unburned fuel, of course, results in excess hydrocarbon emissions and reduced efficiency. By dramatically reducing this quench zone with hypereutectic piston technology, these losses are kept to a minimum.

By maintaining a much closer clearance between the piston and cylinder during all phases of operation, including cold to warm, piston scuffing and friction are kept to a minimum. The distance between ring grooves can also be reduced with a hypereutectic piston. This allows for a better seal and less pressure loss in the combustion chamber. The hypereutectic piston rocks less than a normal eutectic piston when it is cold which helps reduce premature ring wear.

Hypereutectic alloys also stand up to the additional loads that forced induction in the form of turbocharging and supercharging bring to the party. Forced induction engines have become commonplace in modern engines as a method of increasing power while reducing emissions.

It is apparent that this new piston technology is one that benefits both the racing industry as well as the passenger car industry. They are likely to become more commonly used as the demand for lower emissions and power become greater.

Certain concerns exist with other internal engine components as well. Compatibility between camshaft lobes and followers is just one example. Piston-to-valve clearance is another. Valve spring coil bind is yet another, and this concern can be compounded by the use of high-lift camshafts.

As with all engine builds, special attention must be paid to crankshaft and camshaft endplay, valve stem-to-guide clearance, and proper alignment of timing chain or belt sprockets. Engine sealing is another issue of concern, since many OE procedures involve formed-in-place chemical sealants in place of cut gaskets, and many OEs now recommend that chemical gaskets be used at the time of overhaul.

This turbocharged engine got too hot! Lean fuel to air ratios can turn an engine into a very expensive plasma cutter! Note the melted cooling fins on the side of the cylinder.

It would be easy to pass along responsibility for some of these tasks to your machinist or the parts manufacturer. But that would be a cop-out.

It doesn't matter whose fault it is if you install main bearings and the crankshaft doesn't turn. The ultimate responsibility for the functionality of any given part lies with the engine builder. ■

VW Coding Mysteries

Part 1: This is what happens to vehicles when repair facilities do not have the proper tools and training when addressing customer complaints. The vehicle is question is a 2006 Jetta 2.0L TFSI BPY engine with DSG transmission. The question asked in addition to repairing multiple issues was, "Can you get the high beams to work?"

The high beams did work, but in "flash to pass" only.

Side Note: This customer called in desperation after visiting three other shops where none of the complaints were repaired correctly. The main issue was stalling when driving at normal operating temperature. The original scan is included to read as a supplement to this article. The list is what other shops replaced:

- Used radiator (I replaced it again with a new component)
- Used throttle body (I cleaned it and re-set back to basic settings)
- Used Central Electrics (the mystery)
- With a few tests, G28 (crank position) sensor was replaced and the block surface cleaned with a new oil separator.

Step 1: Get an autoscan using a stable power supply.

Note: Addresses 16 - 09 - 55 are on a network. Address 19 is the gateway.

At Address [16] Steering Wheel Electronics, my interest was to measure the live groups to see if Steering Wheel Electronics was capable of producing the proper CAN signals for [09] Central Electrics. Possibly, the output control may also be seen at [55] Headlamp Range.

With the schematic in view, I can see the switch E4 connected to J257 [16] Steering Wheel Electronics and that controller is also attached to J519 [09] Central Electrics and [19] Gateway.

The network command is sent via voltage impulse from:

- E4 > J257 > J519 > Switching N348 and N347 (High-Low beam switch over solenoid) to enable M30 and M32 (High beam lamps).
- That's all I needed to understand for the moment.
- With VCDS, I should be able to match network connectivity and see the measured value differences.
- [16] Steering Wheel Electronics J257 has two networks attached to [19] Gateway J533.

Address [19] Gateway J533 has part number 1K0-907-530-F

With live data, I can see network connectivity in groups:

- Group 126, field 4,Headlight Range (J431)
- Group 130, field 2,Central Electronics (J519)
- Group 132, field 2,Steering Wheel Electronics (J527)
- All are OK [1 = OK and 0 = n.OK]
- Coding at address [19] was obviously correct.

Address [16] Steering Wheel Electronics, J247 has part number 1K0-953-549-AH

With live data, I can see E4 activity in groups:

- Group 001, field 1, Blinker or Signal Lamp Status
- [Range: n. operated/left/right]

- Group 001, field 2, Headlamp High Beam Flasher
- [Range: n. operated/operated]
- Group 001, field 3,High Beam High Switch
- [Range: n. operated/operated]
- Everything operated as normal and coding is correct.

Address [55] Headlamp Range J431 has part number 1T0-907-357-F.

There are no values of interest except for coding and that is also correct.

Address [09] Central Electrics J519 has part number 3C0-937-049-23-H

With live data, I can see the network command from [16] in group:

Group 004, field 3,Left/Right High Beam [Range: 0.0...100.0 percent]

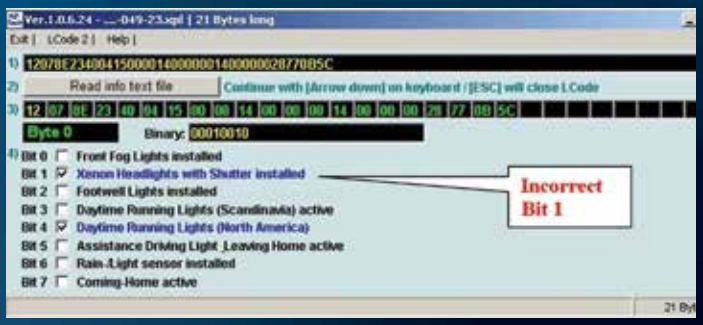
The circuit reads 100.0 percent with the switch in Flash position.

The decision was to look at the coding for [09] Central Electrics because all of the inputs and outputs are as they should be. Looking at [19] Gateway, all of the installed controllers are in communication.

What I found:

Coding was incorrect at address [09] Central Electrics.

Incorrect coding:
12078E2340041500001400000014000000028770B5C



The next two images indicate the incorrect coding with explanations to follow.

Bit 5 is also incorrect for this model

Correct coding:
10078E1340041500001400000014000000028770B5C

(A) This model did not have the Xenon Headlights with Shutter option.

(B) This model did not have the Teardrop Wiping for Rear Window Option

The reason is because the used controller came from a Jetta wagon. The model being repaired is a sedan.

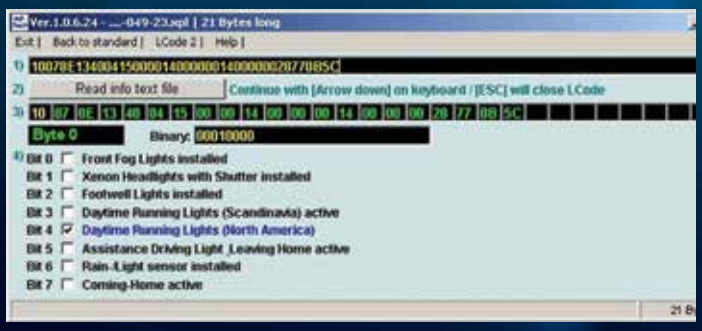
Therefore, the incorrect coding was left or attached to this controller.

This article is the testament of what a complete autoscan can offer a professional technician! The article should also serve as a warning to technicians that do work on these models. Simply; keep every scan and log in a respected folder because that scan indicates the condition of the vehicle as it arrived in the repair facility. You may need that original scan in the future.

This was tested on-line and off-line by using NE-Tech Long Coding tool:

- The next two images are correct.
- The coding is saved and now the high beam function works correctly.

On a final note: Not one controller was opened, removed or probed in any way, shape, or manner. Everything was diagnosed using the original autoscan, ElsaWin and VCDS measuring values.



Notice the difference with the coding now when the model is identified with the correct equipment at Byte 0. Take the time to notice the differences between the two set of images {Correct and incorrect}.

At Byte 3, the last change was made and saved.

With the correct .xml file within VCDS, coding can be tested off-line by using the coding value from the scan. In most cases, there are very few .xml files because coding is now found within the encrypted label.

Part 2: This part of the article examines small mistakes that created larger headaches and fortunately, all of the participants were in sync to correct a problem that should have never been created.

This all began as a theft recovery through an insurance company and the greatest damage was the instrument cluster. How difficult can this be? You would have to pay attention to the "investigation." The model is a 2008 Jetta S with the 2.5L R5 and 09G Automatic Transmission.

Mistake number 01. No original autoscan was created or saved.

Mistake number 02. The dealer installed the instrument cluster and coded address [46] Comfort Control incorrectly (explanation will follow).

Mistake number 03. An incorrect diagnosis was thought correct and the dealer provided the incorrect Comfort Control Module.

This adventure begins with a simple call from a friend asking for technical support for the mentioned Jetta S. As usual, details were passed back and forth but we decided it was far faster for the dealer to install the instrument cluster and program the keys into the immobilizer because he lacked the required equipment for immobilizer adaptation.

The second call was far more interesting for the same vehicle.

Can you imagine the fuel door opening when unlocking the doors with the remote? I've never encountered or seen a fuel door being remotely opened and neither did my friend.

So we start from the beginning and requested the original autoscan. There was none saved from the first time it arrived and before it was at the dealer for the instrument cluster replacement.

It is at this point, we decided to initiate a remote diagnostic session to see how it is possible the fuel door was commanded open via remote.

Step 1. Gather the entire scan

Step 2. Gather a complete schematic

Step 3. Measure the command - it was true and measured

Step 4. Stare at the screen in bewilderment

Using the coding string from the latest scan and reading the coding with the VCDS Long Coding Helper, much of the coding options can be in view from Byte 0 to Byte 2. However at Bytes 3 to 5, nothing is in view to describe the meaning of each Bit. From Byte 6 to Byte 16 coding options are in view. The remaining Bytes 17 and 18 are again with no description.

Within the VCDS folder.

Here is the exact example for this controller of what the coding tool looks like with the correct and incorrect string.

The following is the corrected version and final scan of Address [46] Comfort Control (aka Central Conv.) and the FINAL result
Address 46: Central Conv. Labels: User\1K0-959-433-CT.lbl
Part No SW: 1K0 959 433 CT HW: 1K0 959 433 CT
Component: A_ KSG PQ35 RDK 052 0221
Revision: 00052000 Serial number: 00000000000000
Coding: 13900F887F86081B0904058FB0880F0488DCA0
(Incorrect)
Recoded at dealer during the first repair
Coding: 13900F880186281B0904058FB0880F0488DCA0
(Correct)
Corrected code at dealer and final repair
Shop #: WSC 2250x 444 102980
Component: Sounder n.mounted
Component: NGS n.mounted

Byte 0 (Hex 13)

Byte 4 (Hex 7F)

Byte 4 (Hex 01)

Component: IRUE n.mounted
No fault code found.

How did we get there?

When reading the schematic and operating the remote, the fuel door was commanded open. The tests also proved that there was no stray signal to open the fuel door (V155). The switch at the driver panel was tested via scan tool and meter to prove the signal is correct. The motor at the fuel door was monitored with the correct signal. The signal is true but incorrect for this model. It sure looked like there was an internal problem with the Comfort Control Module. One was ordered (mentioning the scan having the correct part number) and also to order via VIN.

The wrong version was installed, look at the images provided.

With the wrong version installed, more faults, more headaches and the painting became clear. Now for the proof and admitting to a series of mistakes by the parties involved.

(a) The original scan should have been saved for future use (containing the original coding).

(b) Calling a defective Comfort Controller was a mistake.

Looking back at the first scan and with the original invoice, that match was evident of how this all came about.

(c) The dealer installed an instrument cluster and adapted the keys.

Address 17: Instruments
Part No SW: 1K0 920 954 SX HW: 1K0 920 954 SX (remanufactured)
Component: KOMBIINSTRUMENT 3HL 1222

The last digit of five of the WSCs (Work Shop Codes) is removed from each image.

Imp: 444 is a US importer code.

Address 25: Immobilizer
Part No SW: 1K0 920 954 SX HW: 1K0 920 954 SX
Component: IMMO 3HL 1222
Revision: V0005000 Serial number: VWX7Z0Hxxxxxxx
Shop #: WSC 2250x 444 102980 (last shop that coded or replaced)
Address 46: Central Conv.

Part No SW: 1K0 959 433 CT HW: 1K0 959 433 CT
Component: A_ KSG PQ35 RDK 052 0221
Revision: 00052000 Serial number: 00000000000000
Coding: 13900F887F86081B0904058FB0880F0488DCA0
Shop #: WSC 2250x 444 102980 (last shop that coded or replaced)

Since the dealer mistakenly supplied the incorrect replacement controller and recoded the original controller incorrectly, they assumed responsibility and refunded the shop that I worked with. That was very good of them to quickly solve that issue. The proof was supplied/derived from VCDS and their own parts invoice because of their dealer code. The dealer agreed to recode the original controller as it should have been and everything worked perfectly. The vehicle was returned to the shop and again a complete scan was recorded along with the correct coding to Address [46] Comfort Control.

Later on and with some serious digging of saved scans within spare data drives, one matching vehicle was found with the identical coding. Go figure!

The proof?

We changed the coding ourselves and noticed how the remote opened the fuel door as it arrived with the new cluster installed. The correct coding was retuned and Comfort Control worked normally.

The initial scan held a few bits of information of "who" worked on that vehicle last and "who" coded Address [46] Comfort Control last.

Remember that the instrument panel was replaced, and that means that the keys were adapted to the immobilizer. Dealer or non-dealer registered VAG equipment has a dealer number that writes to the controller as "who" if any equipment is coded or adapted via GEKO.

The Message

There will be many times that new components require replacement for whatever reason. In this specific case, the correct part number MUST be installed AND the original coding has to be used or searched from previous saved scans as a direct fit. This and many other models do share the same controller. That is another reason why the new coding formula is used -- fewer controllers having multiple options fitting multiple models that can be turned ON or OFF via Long Coding. ■

Water-based Paint Update

Painters must account for humidity levels when planning a waterborne refinish job. With a little help from the experts at BASF, we've collected tips about how ambient temperature and humidity affect your options of additives, spray application techniques, and drying methods.

BASF recommends spraying waterborne basecoats with a 70 overlap instead of the 50 overlap typically used when spraying solvent basecoats.

Differences in ambient humidity levels have a major impact on the evaporation rate of waterborne basecoats. Professional painters compensate by choosing the additives recommended by the paint manufacturer for ambient conditions at spraying time, adjusting gun setup, increasing or decreasing how wet they spray each coat, and creating turbulent airflow in the booth during the drying process. Once you learn these key procedural differences versus solvent-borne paints, you will find that use of waterborne basecoats offers faster cycle time and easier color match with OEM coatings.

Coating System Components Are Not Mix and Match

Different manufacturers may use very different technologies to produce waterborne coatings that offer the desired color match and durability. Use of incompatible primers, reducers, basecoats, clearcoats and other products may alter application procedures and color match or finish durability. All of the tips in this article are based on products from BASF Glasurit and R-M Onyx paint systems.

FACT: A higher amount of reducer will produce a thinner paint film.

TIP: In high humidity climates, BASF trainers recommend that technicians adjust the amount of reducer added to waterborne basecoats up to between 70 and 80. Water will evaporate faster from the resulting thinner film, and you will get faster flash times between coats.

FACT: The 50 overlap that is typical of solvent-borne coatings results in less hiding if used with waterborne basecoats.

TIP: If you reduce the paint 70-80, and also spray using a 50 overlap, your coverage will be disappointing. Some painters attempt to compensate by spraying wetter, or by spraying more coats. Either way, drying time and cycle time go up as a result.

The better solution is to increase overlap to 70 - 80. You will get a tighter pattern and better coverage, all in fewer coats than if you sprayed using 50 overlap.

FACT: Waterborne basecoats contain 20 pigment in their metallic or pearl formulations, one-third more than the 15 pigment content in solvent-borne basecoats.

This painter is adding Glasurit 929-53 hardener to a mix of a 2 component Glasurit Urethane Sealer to create a ground coat color formula. The resulting gray ground coat enables poor hiding colors such as reds and yellows to achieve coverage and excellent color match with fewer coats.

Adding 90-M4EDT (Extended Dry Time) Mixing Clear to Glasurit 90-Line or R-M Onyx basecoats in high heat, low humidity climates prevents paint film from drying too fast for proper pigment flop.

BASF color formula software interfaces with an electronic smart scale to allow pinpoint control of color mixing.

TIP: Thanks to the higher hiding ability of waterborne basecoats you can spray fewer coats and still get the same coverage. BASF waterborne basecoats usually require 2 medium wet coats plus an effect coat to achieve hiding for most colors and to match the selected ColorMax® color chip. Whether you are spraying metallic, pearl, tri-color or some other waterborne coating type, 2 medium wet coats plus an effect (or mist) coat will dry faster than the same color sprayed in 3 medium wet coats.

FACT: In a hot, low humidity climate such as in Nevada, for example, waterborne basecoat may dry faster than desirable. Pigment flakes may not have enough time to settle at the proper depth and angle in the paint film.

TIP: On a 95 degree F day in Las Vegas, the ambient temperature may be within the normal range for the paint system you are using, but the humidity may be at or below 20 percent in the afternoon (35 percent in the morning). If you are spraying during afternoon hours, the BASF tech data sheet for your paint product may suggest use of a larger gun tip to compensate for the low humidity. This will result in a wetter application, allowing proper settling of pigment flakes during the drying process, and better blending into the panel.

On that same 95 degree F day in Florida or Georgia where you have both high heat and high humidity, you may be advised to use a smaller than normal tip on your spray gun. You'll get a less wet film on the surface, resulting in a faster flashover than if you had used a larger tip.

FACT: Without turbulent air movement, waterborne basecoats take longer to dry. The standard laminar (downflow) air in a paint booth follows the contour of the vehicle or parts being painted. As laminar air flows around the vehicle or part, it creates a boundary layer of slow moving air close to the painted surface, even though air that is further away is moving faster. As water evaporates from a waterborne basecoat, this slower moving boundary air layer quickly becomes

Portable air blowers are significantly less costly to operate than increasing the heat in your booth bake cycle.

saturated with water. The saturated layer blocks and reduces the rate of evaporation of additional water from the paint film.

TIP: Use turbulent air flow to eliminate the effects of a boundary layer. Turbulent airflow provides increased air velocity and multi-directional air movement. Air moving in different directions around the part breaks up the boundary layer, encouraging faster evaporation. In a downflow booth, turbulent air flow can be achieved by adding air movement devices that push air horizontally toward the vehicle or part being painted. These can include stationary mounted devices, portable or hand held devices, and ceiling fans mounted at different angles.

Whether you use a hand-held blower or a fan on a portable stand to create turbulent airflow, always point at a 45 degree angle rather than dead-on (90 degrees) to the panel. Pointing the blower straight at the panel pushes water back into the paint film. Blowing at a 45 degree angle increases evaporation.

If your prep includes blowing dirt off of the vehicle, then cleaning and tacking it, you needn't worry much about turbulent air depositing dirt onto the freshly-painted panel. When blow drying side panels, keep your 45 degree angle to the panel horizontal. Pointing down may stir up dirt from the floor.

FACT: It is difficult to gauge visually whether or not a waterborne basecoat has completely flashed off in order to apply an additional coat.

TIP: Applying clearcoat over basecoat that is not completely flashed off results in die-back (loss of gloss) in the clearcoat. One very effective and inexpensive tool to assist you is a hand-held digital thermometer. After spraying each coat, point the thermometer first to the just-sprayed panel, then to an adjacent factory-finished panel, and compare the two temperature readings. If the just-sprayed panel is cooler than the OEM painted panel, it is still wet. Like a splash of water on a hot summer day cools your skin, water in the paint cools the painted panel.

Training Assistance

When you convert from solvent to waterborne paint, either a BASF technical trainer, a technician from your coatings distributor, or your coatings account manager is there to provide hands-on instruction. In two to three days of real world practice, they will walk your technicians through best practices for paint prep, gun setup, spray application and other process tips. ■

The color and gloss of waterborne paint is not finalized until it is dry and clear-coated. You won't know whether or not you've achieved a good color match until the clear has dried. This makes use of sprayout test panels absolutely critical to success.

Humidity Adjustment Additives for BASF Waterborne Basecoat Products

	High Temp / High Humidity	High Temp / Low Humidity
Glasurit 90-Line Waterborne Basecoat	• 90-M4 Normal Mixing Clear • 93-E3S Slow Reducer	• 90-M4EDT (Extended Dry Time) Mixing Clear • 93-E3S Slow Reducer • You may also add M5 Waterborne Blending Clear at a ratio of 2:1 to a mixed color for blending of a difficult color.
R-M Onyx HD Waterborne Basecoat	• 90-HB002 Hydrobase Normal • HB040 Hydromix Slow Reducer	• 90-HB005 EDT (Extended Dry Time) Hydrobase • HB040 Hydromix Slow Reducer • You may also add HB055 Waterborne Blending Clear at a ratio of 2:1 to a mixed color for blending of difficult colors.

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Photo by Michael Furman | Vehicle courtesy of Don Meluzio

Audi Maintenance Tips

The most common reason for a customer's visit is periodic maintenance. All newer VW/Audi vehicles have built-in service reminder systems. These are used to alert the vehicle owner when it is time for a visit to the repair facility. Generally, the service reminder is set to alert every 10K miles. But this means more than just an oil change every 10K miles!

The Importance of Oil Changes

It is important to educate customers on proper oil change intervals and recommend oil changes every 5K miles. Modern Audi engines are very demanding of the oil they use, particularly with turbocharged or diesel-powered engines. Fully synthetic oil is the only type Audi recommends for their vehicles. Be sure to use engine oil that has the VW/Audi 502 and 504 certification. Using this certified oil ensures proper engine protection and lubrication guidelines set forth by Audi.

Oil consumption is also something customers should be aware of. Many different factors can affect oil consumption, and it is within normal parameters for engines to consume up to one quart every 1K miles. Again, if the customer extends their oil change intervals and does not check their oil levels, they stand a chance of running their engine low on oil, possibly damaging components and causing unnecessary engine wear.

At every service, proper vehicle inspections are necessary to keep the customers and their vehicles happy and running smoothly. Once the technician becomes familiar with the Audi they are servicing, inspecting the vehicle takes just a few minutes and can be done while draining oil, setting tire pressure, etc.

Undercar Concerns

Audi suspension design is designed to be comfortable for the driver but also offers unparalleled handling and safety characteristics.

Audi uses a double wishbone front suspension design on most of their newer models. This system utilizes multiple upper and lower control arms. The double wishbone design is great for controlling the wheel as it moves through the suspension travel and limits camber, toe, and caster changes, thus preserving safety and handling.

Remember to reset the service reminder. It should take just a few minutes, and the customer will be thankful. Most Audi services include performing a full scan of the vehicle as well. This can alert the technician to several possible issues within the vehicle and is an important first step in any diagnosis.

On many Audi engines, the oil filter resides on top of the engine. This makes for a much quicker and cleaner replacement.

The upper and lower control arms contain bushings that take a lot of the shock and load from driving and braking. These bushings tend to be the first to wear out, particularly if the vehicle has been driven in rough conditions.

This upper control arm has small surface cracks but is still in serviceable condition and does not require replacement.

This lower control arm bushing has failed, allowing excessive wheel movement and noise.

Using light pressure on the bushing with a pry bar can help determine if the bushing has failed.

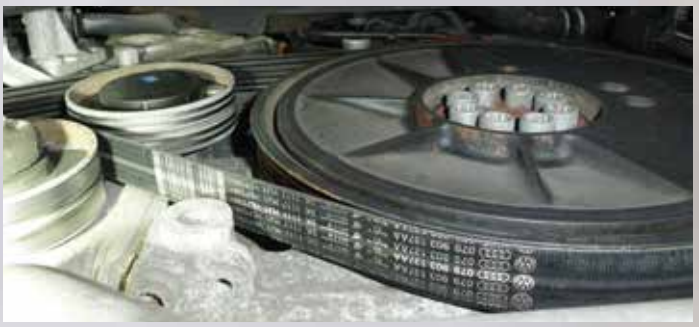
Small tears in the bushing are normal and do not call for replacement. Longer tears that completely separate the bushing mean the it has failed and needs replacement. The upper control arms are readily visible once the vehicle is on a lift.

Often the lower control arm bushings are larger and contain fluid to help dampen suspension movement. It is easy to spot a bad lower bushing by the telltale fluid leakage coming from the bushing. On larger heavier models such as the A8, bushing wear can be accelerated so it is smart to inspect even lower-mileage Audis mindfully.

In certain cases, a bad control arm bushing can cause excessive wheel movement. This can be noted during a test drive as a knocking sound from the wheel area over bumps or when the brakes are applied.

Pay Heed to the Drive Belt

Drive belts are also a wear item that require periodic inspection. Modern Audi drive belts are constructed from EPDM material, which is superior to older rubber drive belts. These belts last a lot longer but when worn do not show cracks or pieces missing like older style belts. The ribs can begin to wear, which leads to eventual belt slippage, heat, and failure. The only way to accurately check the belt is with a small belt wear gauge. If the feeler goes below the rib surface,



A good bushing press kit can service almost any vehicle that comes into the shop.

Replacing bushings can be quickly done on the car with the proper tools.

the belt is worn and requires replacement. Audi generally recommends inspection/replacement of the drive belt between 55K-75K miles.

Don't Forget the Filters

Audi recommends checking and replacing the air filter every 30-40K miles. During replacement, always check and clean debris out of the air box, and check the air intake scoop/snow screen.

Often animals will nest and store food in air boxes, which can result in poor air flow to the engine. Poor engine performance and faults can even be stored if air flow is disrupted.

When checking/cleaning the air box, take a minute and clean out the cowl area for the customer during the service. A clogged cowl drain can flood the vehicle and potentially cost the customer thousands of dollars if left unchecked. Cleaning takes just a few minutes and is necessary if replacing the cabin air filter. It should also be noted to check and clean the sunroof drains if necessary.

Be Battery Aware

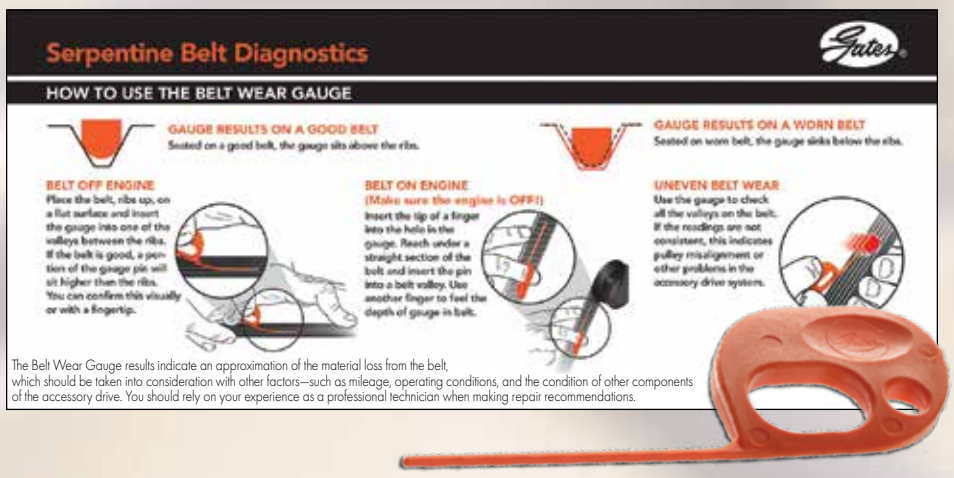
Checking the battery state should also be taken into account during vehicle inspection. It is easy to forget, especially if the battery resides in the trunk, but it should not be forgotten.

Batteries generally last between 5-7 years but can wear out sooner, depending on driving characteristics. A quick load test can determine if a battery is sub-par and requires replacement.

During vehicle inspection, the exhaust system should also be given a once over. In harsher climates, the exhaust can begin to deteriorate quickly, and leaks can appear. Check any flex pipe sections, as well as clamp areas for damage or telltale signs of exhaust leaks.

These are only a sampling of common issues to be aware of. It up to you, the technician, to be thorough when examining vehicles. The safety of the customer is in your hands. ■

Most original batteries have a date code stamp on them. This battery was made in the 28th week of 2009.




Clamps are known to rust out causing exhaust leaks.

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Porsche Coil Considerations

Spark generation has gone high-tech

Example of three early ignition coils. Sometimes bigger is better! The bigger the coil, the more room for secondary windings. This allows for a more powerful, high voltage spark.

Porsches, it can be argued, are a highly sophisticated and quality car. They are unique in many ways when compared to the everyday "grocery-getters" that many of us drive on a daily basis, but all vehicles share certain requirements. Among these requirements is a high voltage, properly timed spark to ignite the fuel and air mixture in the combustion chamber.

Many of us can remember the days when an automobile engine had only one ignition coil. Occasionally one might have seen a system using two coils if the engine had more than eight cylinders, but that was rare. The good old oil filled, cylindrical ignition coil of the past was an extremely reliable component. So reliable, that it was often overlooked as a possible problem when mechanics were attempting to troubleshoot a performance problem. Oh how things have changed!

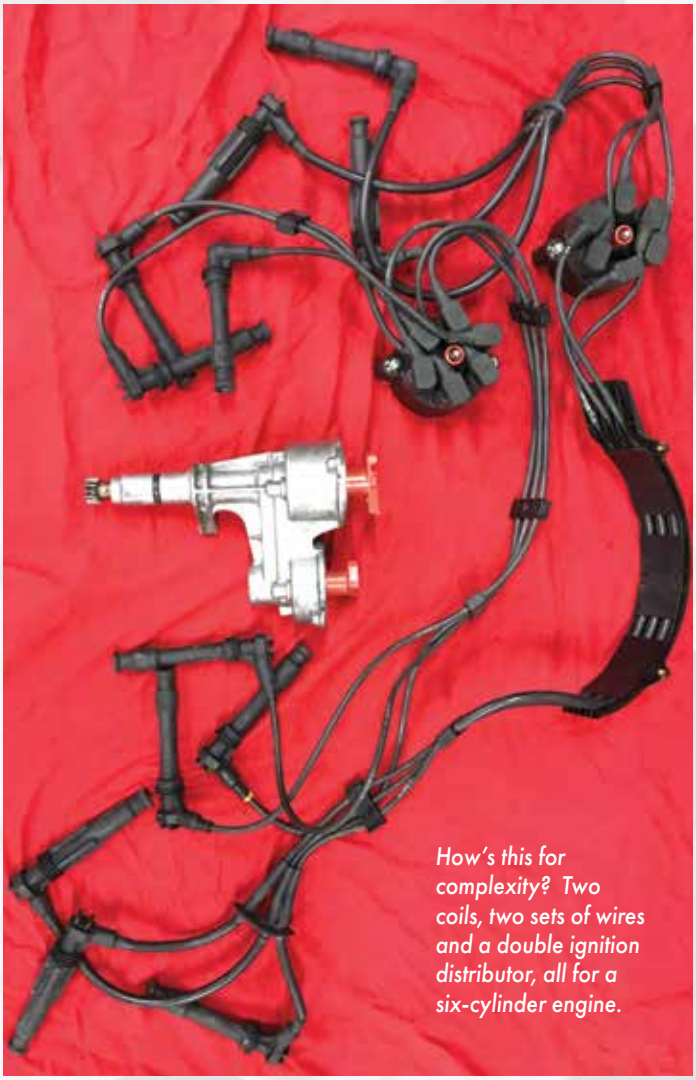
No moving parts

The beauty of a coil it that there are no moving parts to break down. Using the principle of electromagnetic induction, a 12 volt current is applied to a relatively small winding around a core of fine wire made up of many more windings. The low voltage windings create a magnetic field and when that field is collapsed, by interrupting power to it, a much higher voltage output is induced in the secondary windings. This increased voltage, often in excess of 50,000 volts, is what is delivered to the spark plugs to ignite the fuel and air mixture.

Challenges

The drawback to having only one coil serve multiple cylinder engines is that a coil's effectiveness is limited to the amount of time the magnetic field has to build up. This time is referred to as "dwell," also called "coil saturation," and it is necessary in order to have a strong magnetic field so that the output of the coil is at its maximum capacity.

Count the number of sparks necessary to run a typical four-stroke V-8 engine. Each cylinder is fired after two complete revolutions of the engine, so four spark plugs must be fired every single rotation. That means the coil has to build up its magnetic field and collapse four times per revolution. At 5,000 rpm the single ignition coil needs to fire 20,000 times a minute! That is a lot of magnetic field buildup and collapsing going on in a very short time span.



How's this for complexity? Two coils, two sets of wires and a double ignition distributor, all for a six-cylinder engine.

The other drawback is that the single coil ignition system requires an elaborate spark delivery system. Ignition distributors, distributor caps, ignition rotors, and high-tension spark plug wires are all required paraphernalia when using only a single coil. With a system this elaborate, there are lots of potential areas for failure.

Many of us are all too familiar with the common pattern failures in early ignition systems; carbon tracking in distributor caps, spark plug wires leaking to ground and ignition cross-firing, just to name a few. High voltages in ignition wiring can also create a lot of electromagnetic interference (EMI), which is a disturbance generated by all that high voltage current running through ignition wiring, distributor caps and the like. EMI can affect the very sensitive low voltage circuits in a fuel injection system, and can even shut some systems down entirely.

Evolution

It's no wonder that automobile engineers wanted to get rid of the single coil system. Early efforts brought about a coil system that fired two plugs simultaneously, referred to as "waste spark."

This is a typical waste spark system with one coil firing two cylinders.

The idea is that a single coil can serve two cylinders. This coil fires two spark plugs serving companion cylinders simultaneously. One spark plug is igniting the fuel air mixture for the cylinder that is on its compression stroke while the other plug is just firing needlessly on the companion cylinder's overlap stroke.

The reason for firing two plugs at the same time was two-fold: It simplified the triggering of the coil and, by firing two spark plugs at once, it allowed the coil to fire in one direction. That is, the secondary current would flow only in one direction, so the spark would jump from positive to negative on one cylinder while its companion would jump from negative to positive. This can be evidenced by examining spark plug wear.

The plug receiving the "negative" spark would wear out the grounding electrode, whereas the plug receiving the "positive" spark would wear out the center electrode on its spark plug. While the waste spark system does away with the ignition distributor, cap and rotor, it still requires the use of high-tension spark plug wires.

Coil on Plug

The most recent innovation is what most technicians refer to as "coil on plug" systems. Taking the waste spark system to its next logical step, this system assigns a single coil to each spark plug of each cylinder.

Porsche cars, like most modern vehicles, utilize an ignition system that is controlled by the same central processor that orchestrates the fuel delivery to the engine. By controlling both the spark event and the fuel delivery simultaneously, things can be controlled much more precisely and emissions can be kept to a minimum while performance is enhanced.

Modern fuel and ignition management systems are also incredibly fast, so fast that the system has the capacity to change the timing of each cylinder as it progresses through the firing order.

By precisely controlling the ignition event, timing can be altered not only to optimize efficiency and performance, but also to protect the engine from detonation-damaging events. This is especially important for engines with forced induction in the form of supercharging or turbocharging, where detonation is more common. Feedback from knock sensors informs the control unit when to dial back the timing to mitigate the effects of detonation.

Another advantage to coil on plug systems is that the coil now has much more time to build up its magnetic field in the primary windings.

Instead of firing a coil four times a revolution on our V-8 example, a single coil has two full revolutions of the engine to fully saturate the primary windings of the coil, allowing for maximum buildup of spark. This also allows the coils to be manufactured using fewer windings, making them smaller and lighter. The compact design also allows them to be able to fit into relatively small areas, such as on top of the valve or camshaft covers.

Gone are the spark plug wires, distributor caps and rotors. A typical coil on plug design has the coil bolted to the valve or camshaft cover with an electrical suppressor end that attaches to the coil, runs down a long tunnel through the cylinder head and attaches to the spark plug. This location may seem to be ideal, but there are some significant drawbacks; heat, vibration and that pesky tunnel that the suppressor has to span.

Porsche engines, at least the engines in their sports models, utilize a horizontally opposed layout. Among many other advantages, this layout provides a low profile and low center of gravity. It also provides a challenge for coil on plug ignition systems in that the location of the coil exposes it to not only heat from the exhaust, but all the elements; rain, snow and road grime.

It is especially important to inspect these coils on Porsche engines for damage as a result of rust and corrosion from living in this highly hostile environment.

Here's a waste spark "hybridized" with coil on plug. The coil on the spark plug provides the other plug's spark through a conventional high-tension wire.

Half of a V-6 engine shows one coil for each of the three cylinders. This allows enough time for thorough coil saturation.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Ignition coils by nature generate a significant amount of heat due to the constant flow of electrical current. By locating them on the top of a valve or camshaft cover (their more common location) the heat issue is made more problematic. The constant heating and cooling of any component causes breakdown of materials and can be attributed to shortening the lifespan, especially for a component that is relatively fragile to begin with. Now add some vibration in the form of a reciprocating engine sitting underneath it and you're exposing these poor coils to a double-whammy.

The suppressor connector running down that tunnel to the spark plug also adds some additional challenges for modern ignition systems. The valve cover gaskets can eventually leak into that tunnel and allow oil to pool up around the base of the spark plug and the suppressor connector. While oil is a decent insulator, it can contaminate the connection point and generally make a mess when it is time to change the spark plugs.

Now visualize that suppressor connector running down that tunnel through the cylinder head. Just like a spark plug wire can leak voltage and arc to anything metal, the same voltage can leak through the insulation on the suppressor and arc to ground rather than jump the gap at the spark plug. The only difference is that you can't see the problem like you often can with external spark plug wires. So it can be difficult to tell if a dead cylinder is a problem with a coil or the suppressor.

Servicing spark plugs on a horizontally opposed Porsche engine presents a few more challenges than a "normal" engine layout as heat shields are often in the way and accessibility is not very convenient. It is important in these situations to carefully evaluate the ignition coils you must remove to access the spark plug. A technician must ask him or herself whether the coils will last as long as the new spark plugs that are being installed.

We all hate comebacks, and conscientious technicians are often concerned about replacing parts that may not seem to be necessary. None of us wants to leave our customers feeling as though we have tried to gouge them by running up a repair bill needlessly. That's why this is an issue that needs to be dealt with delicately when spark plug replacement becomes necessary.

Spark plug replacement intervals are rarely less than 60,000 miles these days. It is impossible to guarantee that your ignition coils and suppressors will outlast two spark plug changes over the course of 120,000 miles. If you, in the spirit of saving a customer some money, re-use the coils and suppressors, who do you think the customer is going to point the finger at if a coil or suppressor fails shortly after the coils have been removed and reinstalled? The random misfire problem following shortly after a spark plug service is, in the customer's mind, going to point a finger directly back at the technician who performed the service.

Communication is one of the most important and sometimes difficult aspects of the business of auto repair. Establishing a relationship based on trust is the essential first step. By communicating clearly to your customer the pitfalls of re-using parts that may fail in the near future you will be taking steps to build a relationship based on trust. ■

Were is not for the fact that this engine is out of the car, one would not be able to even see these coils. Servicing coils and plugs on this engine requires removal of exhaust components, heat shields and whatever else happens to be in the way.

How's this for a bad environment? This coil has to live under the engine where all the water, ice and road salt can attack.

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Install confidence. Install Genuine OE Volkswagen Batteries.

Volkswagen

VW Wire Harness Inspection and Repair

Broken and poorly repaired wiring can cause electrical draws, inoperative accessories, and intermittent problems.

With each new generation, Volkswagens have become increasingly high-tech. Innovations, including advanced safety systems, adaptive cruise control, parking systems, etc., all rely on one thing to work together — the wiring. VW, being one of the largest auto manufacturers in the world, strives to lead the pack in advances. And, with more and more convenience and safety designed into their vehicles, the enormous amount of wiring required can be staggering.

The wiring harness that connects every system of a modern VW works like the central nervous system of a body, connecting every part of the vehicle to critical systems. VW does its best to maximize wiring efficiency and design. It is an essential assembly of cables or wires that transmit signals or electrical power. And it has the potential to save lives, from the most mundane task of a lighting circuit, to the safety system wiring that connects to air bag circuits, to ABS systems, and to other critical safety, comfort, and convenience systems.

Without these systems functioning correctly, several different issues may arise. Some problems may seem random, others not. Often, faulty wiring connections cause sensors to give false readings, leading to a misdiagnosis of problems. As with most vehicle issues, it is wise to begin diagnosis with a full vehicle scan. Volkswagen designs vehicle systems with diagnosis in mind, and many electrical faults may be stored in vehicle control units.

Great care is taken by Volkswagen to protect the wiring on their vehicles. However, issues sometimes still occur as a vehicle leads a very difficult life, subjected to extreme heat, cold, vibration, and water intrusion, which is the most damaging to the wiring system.

Issues with wiring and connections can be challenging to diagnose properly because they are much less common than individual component failures. But with some patience and basic understanding, even difficult issues can be resolved.

Flexing

Any time a wire is flexed, it is stressed. Constantly stressing a wire eventually begins to break down its insulation. This is bad for several reasons. If enough insulation becomes damaged or destroyed, the exposed wiring may short out. If multiple wires short out simultaneously, this can be very problematic. Burnt wiring, popped fuses, and loss of vehicle system functionality can occur.

There are many locations in a vehicle that require wire movement, or flex, to allow proper use. Doors, seats, tailgates, trunk lids, and even the hood of a car may have wiring running through it that must flex. Many VW harness kits are available seperately, and can be replaced rather than repaired.

All doors have wiring that must move or flex so they can be fully opened. Certain VW models offer door handles that have wiring for lights or keyless entry that must be able to move. The door harness, particularly on the driver's side, gets a great deal of abuse in most vehicles. This harness usually has numereous systems dependent on its proper operation. The power locks and vehicle alarm both have to pass through the door. Power windows, power mirrors, and speakers all rely on the door harness. The most critical of these wires is for any air bag wiring that may run through the door. Side impact sensors often reside in door cavities. That is a lot of wire to run to each door!

If a sunroof drain is clogged, connectors at the base of the A-pillar will quickly take on water, leading to problems.

Accidents

In cases when a VW is in a collision, wiring damage may not be apparent or easily identifiable. During repairs at a body shop, a wire that has been scraped or crushed from an accident may go unnoticed.

Most commonly damaged, from accidents to front and rear bumpers, are parking sensor and marker light wiring. These often run across the bumper frame just beneath the bumper cover. Any impact can damage these sensitive wires, and such damage may not be readily apparent.

When there is accident damage to vehicle doors and body panels, other systems may be affected, in particular air bag impact sensors and window motors/modules that reside inside the door panels of certain models.

Body panels, particularly in the rear, typically house several components that can be damaged from accidents. Often, stereo and connectivity components are located in the trunk recesses, particularly in larger VW models. If damage to modules or wiring is suspected in this area, close inspection is necessary. Crushed or pinched wiring is often the culprit in these cases.

Water Intrusion

Water intrusion is also a large contributor to wire damage. Great care has been taken by VW engineers to properly manage water intrusion, but it is difficult to plan for every aspect of harsh environments. It is common knowledge that water and electricity do not mix. Water can short out connectors, build corrosion that may cause intermittent connection issues and, if water gets inside any of the electronic control modules in a vehicle, it can destroy them in short order.

Cars have to live in a harsh environment, which complicates protecting important components. Two key areas that are the most susceptible to water ingress are the sunroof and the cowl drains under hood. These have to deal with the majority of rainwater and divert it for proper draining.

VW service states that sunroof drains should be cleaned at least every 30K miles, and sooner in cases where the vehicle may be parked outside under trees or in certain climates. Most often, a blocked drain is due to dirt and plant matter accumulation. If such blockages are left without repair, the drain water can quickly become an issue. Front sunroof drains are the most common to experience clogging. When these drains become obstructed, rainwater travels down the A-pillar and drains inside the vehicle. The components that lie below this part of the vehicle are susceptible to damage, as they may be electrical components. These can be fuse/relay boxes, door harness connectors, and electronic throttle units.

Rear sunroof drains also must be cleaned periodically. Failure to clean these drains, particularly in Jetta and Passat wagon models, can result in ingress at the rear corners of the vehicle, which also may contain electronic components. Often stereo and connectivity components are placed here.

If you suspect water damage at a certain connector or area of the vehicle, it is easy to undo the connector and inspect for corrosion. In cases where there is water damage, the connector may appear discolored, usually appearing to have a light greenish chalky color. This is corrosion buildup that is impeding current and signal flow. Over time, this corrosion can completely cut off flow. The damaged wire, connector, and water leak will all need to be repaired to return the vehicle to proper working order.

The cowl drains elsewhere in a vehicle also contribute to water ingress if left unchecked. When the underhood cowl drains become clogged, the water often overflows directly into the vehicle's fresh air inlet. This will force water into the interior of the vehicle and collect on the floorboards. Many early 2000 Passat models suffered from water ingress issues. The main body harness typically runs through the floors, and water can make its way into connectors and splices there, resulting in a myriad of issues. Close visual inspection is best here, checking for split insulation, corrosion, and broken wires. Often, electronic modules are also located in the floorboards and can quickly be submerged and damaged from water.

Doors

Another area of the vehicle that sees tremendous use is doors. With numerous convenience features available in modern VWs, a lot of wiring has to travel to the doors, more so in the driver's side. This wiring, being constantly flexed, sometimes degrades. Often, a customer's complaints will lead you to a faulty door harness wiring. Nonfunctioning windows and inoperative power locks are the most common complaints. It is smart to do a full vehicle scan as a first step in diagnosis. This will help take you in the right direction if there are multiple system faults such as short to ground or open circuit faults in any of the vehicle systems that share the door wiring.

If the door harness is suspected to be compromised, it is sometimes easy to visually examine the harness for failure. Most vehicles have a rubber covering with grommets to seal the door harness where it flexes. This can be popped off from one end and slid back, exposing the point in the wire that flexes the most. This is where most door harness breaks occur. Any open/cracked insulation has failed. The Mk5 Jetta model is known to have common door harness failure. The flex section was originally designed too short, causing wire stress and insulation failure.

If it is not possible to completely see the flex point in the door wiring, a tug test may work as well. Lightly pulling on each wire to determine if it is broken is a great way to check for failure. Test every wire because it is common to have multiple breaks in the same harness. Take extra care with power wires. You do not want to ground these out on the chassis or any other wiring near by.

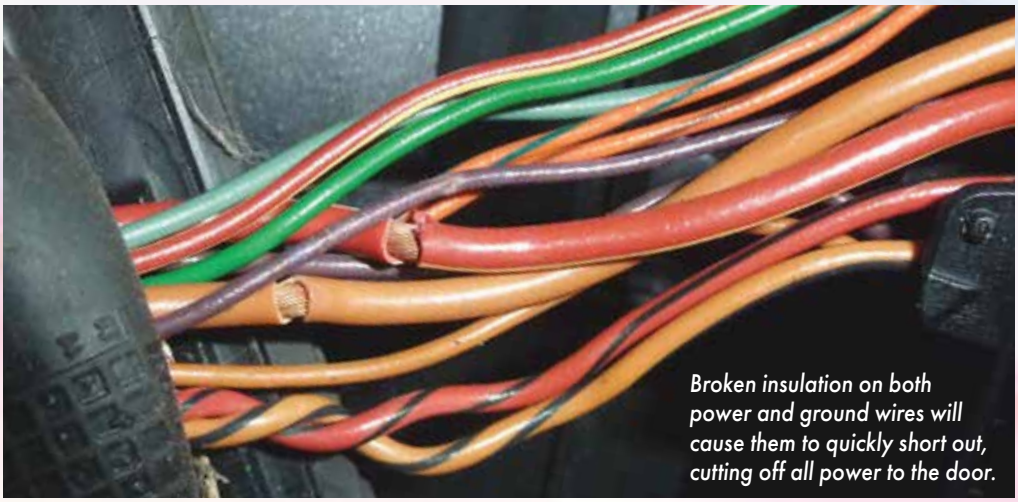
Repair is often possible. But care must be taken to allow for proper movement of the wiring, as well as any air bag connections, in which extra care must be taken. In cases where multiple wires have been damaged or show signs of deterioration, replacement is your best option to eliminate future issues with the same area.

Trunk

The trunk or tailgate of cars also have wire looms passing through them. These are usually for lighting circuits and trunk latch wiring. If a vehicle gets a lot of use, the trunk harness insulation may begin to degrade. Issues with power to lighting and finicky trunk latches can usually can be traced back to a broken wire in the trunk harness. This is common with vehicles across all makes.

Seats

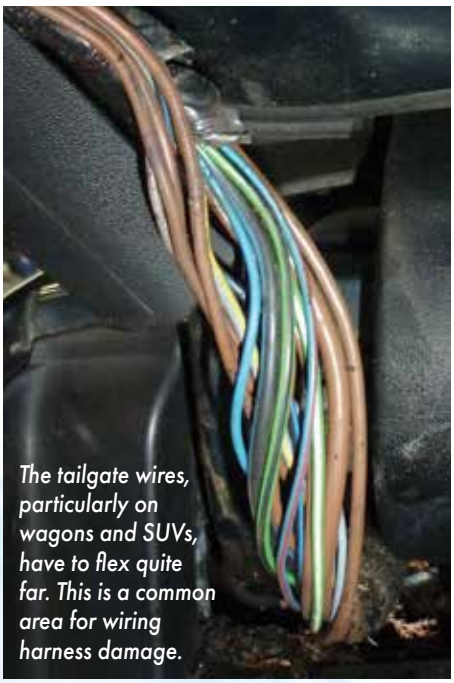
The seats of most vehicles are also susceptible to wiring issues. Through constant movement, and even liquid intrusion, the seat harness gets a lot of abuse. This harness can power seat adjustment motors, heated seats, and, most importantly, the air bag wiring for the side impact bags, which are commonly located in the seat bottom.



Broken insulation on both power and ground wires will cause them to quickly short out, cutting off all power to the door.

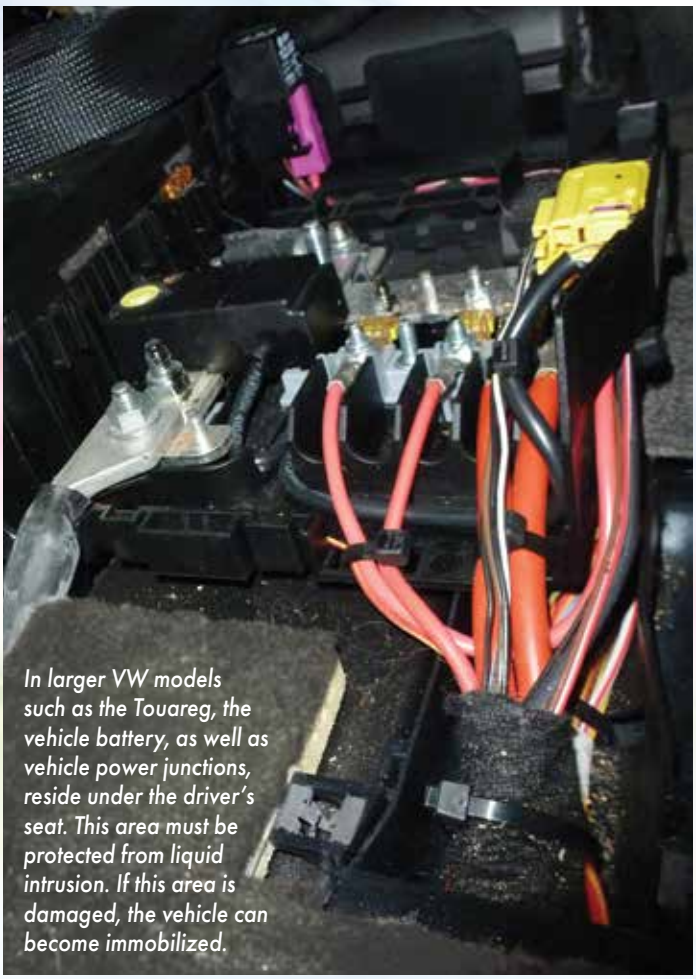
If not periodically cleaned, the cowl area will eventually clog, leading to water ingress.

The air bag system for seats relies on a specific resistance value to properly report air bag condition. Any damage to the wiring can degrade the signal sent to the vehicle's air bag module. This most often results in an air bag fault stating high resistance in the circuit or air bag itself.



The tailgate wires, particularly on wagons and SUVs, have to flex quite far. This is a common area for wiring harness damage.

The most common source of faults in the air bag circuit is the connector under the seat. This connector gets stretched every time the seat is moved. It can eventually spread the pins on the connector, causing intermittent connections. This area of the car is also susceptible to liquid intrusion, and if liquid is spilled onto these connections, it affects the resistance of the wiring, resulting in an air bag warning light. Often, merely releasing the connector then re-seating it is enough to return the wiring to reading properly. A more complete repair for this issue involves replacing and re-pinning the connector to the seat air bag.



In larger VW models such as the Touareg, the vehicle battery, as well as vehicle power junctions, reside under the driver's seat. This area must be protected from liquid intrusion. If this area is damaged, the vehicle can become immobilized.

When repairing air bag connectors, it is critical to follow proper precautions. In certain cases, VW does not recommend repairing connectors or harnesses, and replacement may be necessary.

The first step in any air bag work is to disconnect the vehicle battery. Many technicians avoid or forget to do this critical step. If an air bag accidentally deploys, particularly while being worked on, it can be deadly. Do not forget to disconnect the battery! Death or serious injury may occur if care is not taken in the repair process.

VW designs air bag connectors specifically for their task. They rely on certain resistance values, and pins in most of these connections are gold tinned. This ensures very low connection loss. Repairing an air bag connector is not a standard wiring repair. Cutting and splicing a butt connector will not suffice and may cause resistance values to fall out of spec. A crimped/sealed water-tight connection is the best possible repair to ensure proper function and long-term durability.

Any time a repair is made where multiple wires lead to a connector, it is wise to stagger the splices. Don't merely cut all the wires in one spot, as this creates a huge bundle of splices in one location. This can cause fitment issues, as well as potentially create future issues due to wire stress. Following the wire back an inch or two for each splice keeps the harness tighter for better fitment and wear, particularly in an area where the harness must have flex and movement.

Fiber Optic Data Transfer

With modern vehicles, it is also increasingly common to have fiber optic data transfer systems. These are mainly used for entertainment systems, also known as the MOST bus system. From audio, voice, video, and data, they ensure a lightning fast communication with very high bandwidth, allowing maximum data transfer speed. The difference between fiber optic and normal wiring is how the data is transferred.

In a normal copper wound wire, the data is sent and received via electrical impulses. In an optical system, light is used to communicate to multiple modules, then decoded back to a digital signal.

Just like with standard wiring, the fiber optic system must be completely intact to communicate properly. The fiber optic wiring is comprised of a plastic core, which in itself is not as flexible as a standard wire. Care must be taken when handling. The wire is relatively strong. However, it can be snapped or scraped. Any light loss in the system will cause data loss. This data loss will be transferred to any module connected to the optical system.

When searching for damaged fiber optic wiring, keep in mind the characteristics of the material. It is a semi-rigid plastic material that is not as flexible as normal wiring. It must have smooth radius bends. Otherwise, it may be damaged. If a vehicle has been damaged from an accident and CAN issues are suspected, it is wise to inspect the wiring for this system. Any hard kinks or bends can be the root of communication issues. Remember, this system must transfer light and will not operate properly without a clean signal line.

When diagnosing an optical data system, only a few tools are required. The most crucial tool to help diagnose these systems is a fiber optic system jumper. This tool can be placed in the optical wiring connector of a module to bypass the suspected failed module. If the module is bad, communication will be restored to systems further down the data line.

An important tool for any optical system diagnosis is the MOST bus jumper/loop tool.

The optical data systems in automotive applications all work off of the MOST bus system. This is a ring of modules that all communicate to a main control unit. The data flow is one way on these systems, which means that any failed module or wiring on the "ring" will disrupt communication to the modules after the failure. This is why the fiber optic jumper tool is such a good tool to use in diagnosis.

If damage to fiber optic systems is found, it is more complicated to fix than a standard wire, where cutting and crimping may suffice. To ensure proper optical data transfer, the light signal must not be degraded. Special cutting tools, as well as polishing equipment, are necessary to ensure a flush even connection, as well as a clear polished connection between the two surfaces. It may be necessary to repair an optical line in cases where it may not be possible to replace the entire section of wiring.

The MOST bus master sends out the optical data to the rest of the system. It continuously updates the other modules.

With every wire or connector repair, it is critical to have the correct tool for the job. Having the right connector release tools and crimping tools is essential. Improperly removing wiring can damage connections, spreading the contacts and causing poor connection issues. When crimping new connectors on repair wire, it is important to follow proper procedures; otherwise poor connections may result. ■

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VW A/C Lubricant and Refrigerant Pairing

It's More Than Just Viscosity

Specific Sanden and Denso compressors are interchangeable in many 2011-2015 Volkswagen R134a systems. Here's why you'll need to flush the oil in the system whenever you switch from one compressor brand to the other.

Lubrication is critical to maintaining the service reliability of an air conditioning compressor. The lubricant must first and foremost create an oil film that reduces friction between moving parts, to enhance fuel economy and minimize wear. It must also carry heat away from moving parts, and help seal system clearances and reduce compressor noise.

Additionally, the lubricant must be able to withstand high operating pressures, plus temperatures that change from extremely high near the compressor outlet, to very low around the evaporator.

Further, it must have no chemical interactions that reduce cooling efficiency or create by-products that may be harmful to seals and metallurgy in the system.

Dancing together: The refrigerant/lubricant mix

This is further complicated by the fact that the lubricant must mix with and be transported around the system by the refrigerant. As it moves through the system, the refrigerant/lubricant mix must meet different requirements in various components.

The compressor tends to need a lubricant-rich, higher viscosity mix to protect moving parts and assist with sealing and noise reduction. In the vapor line, high viscosity lubricant may be less desirable. A thicker oil is more difficult for the vapor to transport. This can result in lubricant building up in traps in the evaporator or low points in lines, where it can alter pressures and reduce heat transfer. The evaporator would prefer a mix that features just the right amount of refrigerant: not so much as to cause flooding or allow liquid refrigerant to flow back into the compressor (liquid is not compressible, and can cause excess wear on compressor parts), and not so little that the refrigerant boils away before allowing the evaporator to extract the maximum heat from the airflow.

If the refrigerant oil viscosity is too low, the film is too thin, and the piston may rub against the cylinder bearing surface, causing wear. If the viscosity is too high, the thick oil may be unable to squeeze between the cylinder and the piston, causing the compressor to work too hard, leading to cooling inefficiency and possible damage due to overheating.

Temperature and pressure are bossy

Whether or not a refrigerant/lubricant mix remains in the proportion required by the system at different temperatures is a function of the interaction between the temperature and load in various regions of the A/C system, the lubricant formulation, the refrigerant, and the operating envelope of the A/C system. The Critical Solubility Temperature (CST) is the temperature at which the viscosity of an air conditioning oil will change enough to make it drop out of solution with the refrigerant. At either end of a CST range determined by the lubricant formulation, the oil can alter its structure enough to drop out of solution. At temperatures above approximately 100 degrees F (40 degrees C), a polyalkylene glycol (PAG) oil formulation not matched to the A/C system on the vehicle could separate from the refrigerant. A/C refrigerant can see as much as 500 degrees F (260 degrees C) in certain areas.

PAG is available in 46, 100 and 150 centistoke (cSt) viscosities, plus a few other less widely used formulations. Viscosity is a way of rating how thick an oil is and how easily it flows. The oil must be thick enough to maintain a film on which moving parts can float, and thin enough to flow into narrow spaces between those parts.

A higher cSt (viscosity) number indicates greater resistance to flow. A lower cSt rating means the lubricant flows more easily.

Of course, it is not as simple as that. An oil's thickness and ability to flow are significantly affected by temperature and, to a lesser extent, other factors.

As the temperature of the lubricant increases, its viscosity decreases, allowing the oil to flow more freely. As temperature goes down, lubricant resistance to flow goes up, and its measured viscosity increases.

If you replace a Sanden with a Denso (shown here) compressor in a 2011-2015 Volkswagen, you'll need also to flush the system to remove the existing oil. The Denso compressor requires a different PAG formulation than the Sanden. The two PAG oils cannot be mixed in the same system.

Pressure, or load, also influences viscosity. As the load increases, it makes it harder for lubricant to flow, which raises the measured viscosity of the fluid. The lower the load, the easier the lubricant flows, and the lower its viscosity. Gas temperature increases as pressure goes up, so a lubricant's ability to resist heat is critical in high-load conditions. Excess heat causes lubricant decomposition, which can lead to oil starvation and compressor failure.

Application-specific requirements

The nature of demands on the refrigerant/lubricant mix – having a viscosity range that is thick enough to provide an oil film that doesn't break down under high-temperature, high-pressure conditions in the compressor, while thin enough to provide low-temperature flowability in the evaporator, offering compatibility with seals and metals, and resisting moisture absorption – is further complicated by the fact that each compressor and air conditioning system can be very different. In addition to the presence of different metals and seal materials, something as simple as different inside diameter of the lines in various systems can significantly impact flow velocity, pressure drop, and other performance parameters of the refrigerant/lubricant mixture. This of course means that the lubricant selected must be fine-tuned to the specific operating envelope of the vehicle and A/C system in which it is installed.

Application-specific R134a lubrication recommendations typically exist because the compressor has certain engineered characteristics that maximize performance when used with either a lighter or heavier viscosity oil. For example, while most modern compressors are designed with tight tolerances and will deliver better fuel economy when used with a lightweight oil, some heavy-duty compressors need a thicker oil in order to withstand the load and temperature extremes they are designed to handle.

Slick switch

A real-world scenario is the need to switch lubricant if you are replacing a Sanden with a Denso compressor (or vice-versa) in a 2011-2015 Volkswagen (all models except the Routan). Both are R134a systems and use PAG oil, but each compressor brand requires a different PAG formulation. You must flush the entire system to remove all of the existing PAG oil before installing the replacement compressor.

For example, in a 2012 Passat, the VW-approved Sanden compressor is model number PXE 16, and the alternative from Denso is model number 7SEU17C. The approved PAG oil for the Sanden is VW part number G 052 154 A2; for the Denso it is G 052 300 A2. See the Volkswagen Tech Tip (TT 87-14-01) for details.

Not only are the lubricants different for each compressor brand, but the total system capacity also differs. The lubricant capacity of the Denso

compressor is 140 +/- 10 cm^3 (4.7 +/- 0.3 ounces), for the Sanden, it is one ounce less (3.7 +/- 0.3 ounces).

Trust, but verify

As a new vehicle is on the drawing board, engineers test and approve a potential lubricant for its specific air conditioning system application. Only lubricants that maintain their viscosity, solubility with R134a, chemical stability, and resistance to moisture and acid over a wide range of temperature and operating pressures, among other requirements, receive Volkswagen approval. Without testing, the company has no way of knowing whether a lubricant meets the performance requirements of a specific application, and so use of non-approved lubricants cannot be honored in the event of a resulting problem.

No oil balancing

Factory-new Sanden and Denso replacement compressors for 2012 and newer Volkswagen vehicles ship with the correct type and amount of PAG oil pre-installed. Unless you are working on a dual-evaporator vehicle, do not add more lubricant. The oil in the new replacement compressor is equal to the total system capacity, and will be distributed through the refrigerant circuit upon initial startup. If you are installing a new replacement compressor for an older Volkswagen, check the literature that came with the compressor to determine how much, if any, oil was pre-installed.

After the hoses are connected, but before initial engine start, rotate the compressor by hand at least fifteen times. This moves some of the oil out of the compressor, which helps reduce the potential for liquid slugging upon startup.

If you are repairing a vehicle with two evaporators, you will likely need to inject additional lubricant. Refer to the sticker under the hood for the system capacity.

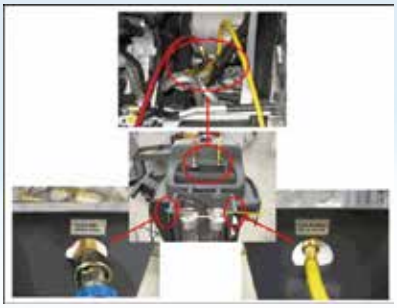
Look up the repair procedure in the VW ElsaPro system or in your service information system. The most up-to-date information will be in ElsaPro. It is a VIN-driven system that provides individual vehicle lookup based on the build specifications for each vehicle. It eliminates the variables and unknown factors of the old-school oil balancing method. You simply flush the system and install the specified oil charge.

If installing an aftermarket compressor that was sold without pre-installed lubricant, or re-installing the existing compressor after repairs to other A/C system components, drain the oil from the compressor before re-installation. To extract as much oil as possible (applies to 2012 and newer Beetle, 2010 and newer CC, 2006 and up Eon, and 1992 and up Golf), remove the oil drain plug and hand-turn the ribbed belt pulley or magnetic clutch plate on the compressor until oil stops flowing out.

After flushing the A/C system, add the amount of refrigerant oil specified by ElsaPro or your repair service information. Inject approximately half of the total lubricant charge directly into the compressor. Make sure to include any additional lubricant needed for systems with a second evaporator.

The ROB134APF Air Conditioning Service System with VAS 6337/1A Air Conditioning System Flushing Device offers complete refrigerant recovery, evacuation, recharge and system flushing in a single service machine.

In the era of R-12 refrigerant use, mineral oil was the lubricant of choice. Mineral oil is miscible with R-12, meaning it dissolves into and flows with the refrigerant throughout the A/C system. But mineral oil does not mix well with R134a, the refrigerant charge for all Volkswagen vehicles manufactured for sale in the U.S. from the mid-1990's up through 2016.



Connecting from the vehicle to the service equipment and then to the flush machine allows you to perform a system flush in the opposite direction of the normal refrigerant flow.

R134a systems in Volkswagen vehicles use PAG as the factory fill lubricant. PAG oil is a synthetic lubricant that offers better solubility in R134a than mineral oil. PAG oil will not dissolve completely into R134a, rather it will form little globs or clumps that are pushed around the system by the refrigerant.

In addition, Volkswagen-approved PAG oil contains lubricity and antioxidant additives and end-capped formulation that help it remain chemically stable over a wide temperature range. It better resists breakdown of its lubricating film, even under high pressure and temperature in the compressor.

Water torture

PAG oil is hygroscopic (attracts moisture). Moisture in high temperature and pressure conditions can react with any impurities in the system and form acids, which are corrosive to metals. Close PAG oil containers immediately after use to prevent moisture entry.

(Continued on page 42.)

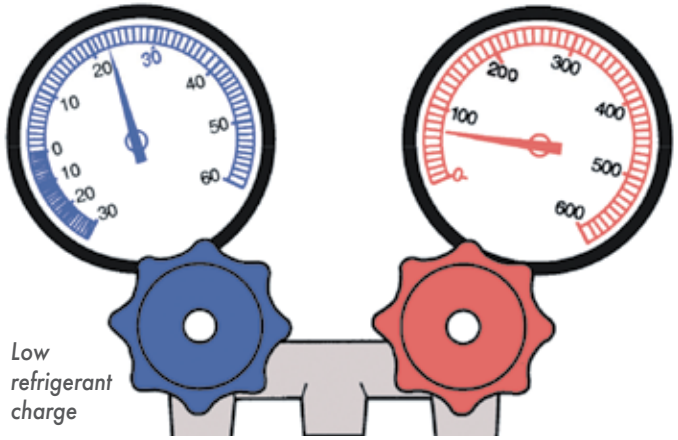
A/C System Diagnosis Using Refrigerant Pressures

If an A/C system performance test verifies a customer complaint of poor cooling and no trouble codes exist to guide your repair process, checking A/C system refrigerant pressures can help point you in the right direction. Remember that static refrigerant pressures are dependent on ambient temperatures, and so the relationship between temperature and operating pressure can sometimes indicate whether the system has an adequate refrigerant charge, or if there are other refrigerant system problems.

Check the operating pressures and temperatures table for the specific vehicle and A/C system you are working on to help narrow your diagnostic focus to a part of the system that may not be within the specified performance range.

Following are a few examples of problems and their potential causes.

Component	Refrigerant state	Approx. psi	Approx. °F
A/C compressor high side	Gas	Up to 290 psi	Up to 158 °F
Condenser	Gas, vapor liquid	Up to 290 psi	Up to 158 °F
Restrictor	Liquid, turns to vapor	High side: up to 290 psi Low side: >22 psi	High side: up to 140 °F Low side: >25°F
Evaporator	Vapor, turns to gas	>22psi	>25 °F
A/C compressor low side	Gas		



Low refrigerant charge

Condition 1: High pressure remains at static pressure and increases only slightly, low pressure drops quickly to suction pressure.

This may indicate a low refrigerant charge.

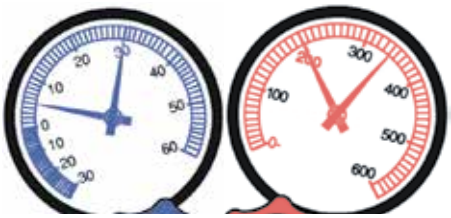
Condition 2: High pressure increases only slightly above static pressure, low pressure drops only slightly below static pressure.

This may indicate a faulty compressor.

A/C compressor faulty

Condition 3: High and low pressures normal. After a period of time, high pressures rise above the specified value, low pressure drops below the specified value.

This may indicate the presence of moisture in the system, and restrictor or expansion valve icing.



Moisture in system, restrictor ices up

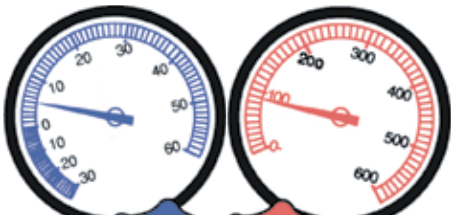
Condition 4: Low pressure too low, low pressure switch shuts off compressor, proper cooling performance is obtained when system operates.

The low pressure switch may be faulty, or there may be a compressor problem.

Low pressure switch faulty

Condition 5: Low pressure too low, low pressure switch shuts off compressor, proper cooling performance is not obtained when system operates.

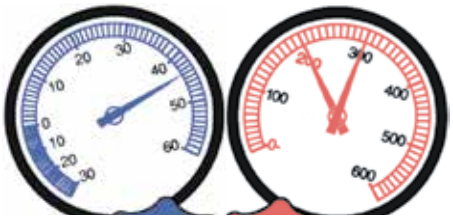
This may indicate a low refrigerant charge.



Low refrigerant charge

Condition 6: Low pressure too high, high pressure normal or increases above specified value.

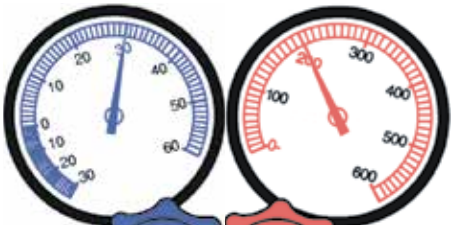
This may indicate a system overcharge.



System is overcharged

Condition 7: Low pressure normal, high pressure normal, proper cooling performance is not obtained.

This may indicate there is too much refrigerant oil in the system.



Too much oil in system

Source: Volkswagen of America, Inc.

The dryer, dryer bag or dryer cartridge in the system can absorb approximately 7 grams (1.42 teaspoons) of water before becoming saturated. If any more water is in the system, it flows up to the expansion valve (TXV) nozzle or restrictor. There it freezes, causing the TXV to become stuck open or closed, and reducing cooling performance. Pull a deep vacuum after refrigerant recovery – the A/C system will thank you.

Also, do not add other types of lubricant to R134a systems containing PAG oil. It does not mix well with other oils.

Flush with Refrigerant

Inspect the extracted oil for any signs of contamination. If you find increased opacity versus fresh oil, color change to red, or the presence in the oil of metal filings or other foreign matter, you need to flush the system before installing replacement components. If you are switching from a Sanden to a Denso (or vice versa) replacement compressor, you must flush all of the existing oil out of the system even if you found no evidence of contamination, as each compressor requires a different PAG oil formulation. On vehicles with two evaporators, disconnect the circuit to the second evaporator and flush it separately from the first evaporator.

Volkswagen allows flushing with R134a refrigerant, or with compressed air plus nitrogen. Flushing with refrigerant R134a is the preferred method. Using compressed air and nitrogen does not achieve the level of cleanliness of flushing with refrigerant R134a. The refrigerant loosens oil deposits, allowing more effective cleaning with less effort.

Compressed air and nitrogen should be used for cleaning individual components, and only if there is no possibility of flushing the entire system with refrigerant R134a. If contaminants are located in a single component, or pressure and temperature readings indicate the likelihood of moisture in the system, the combination of compressed air and nitrogen may force moisture and contaminants out of the component or system. Note that the restrictor (orifice tube), expansion valve, compressor, receiver and reservoir (accumulator) cannot be flushed using compressed air and nitrogen. On condensers that contain an integrated receiver/dryer, remove the dryer cartridge before using compressed air and nitrogen.

First, blow out particulates with compressed air, then remove moisture from components using nitrogen. Refer to ElsaPro or your service information for details about the correct selection and usage of adapter(s) for connecting the pressure hose to the refrigerant circuit.

Use the A/C Service Station with Flushing Device – VAS6381 – or Air Conditioning Flush Tool – VAS6337 – for refrigerant flushing. The flush function and flushing tool are built-in on these A/C service machines, and appropriate adapter sets are available through the Volkswagen Special Tools Catalog.

The machine will automatically perform at least three flush passes to ensure that as much contamination as possible has been removed.

Remove the orifice tube and accumulator, or expansion valve and receiver/dryer, if equipped. The accumulator could be flushed, but it requires a lot of refrigerant due to its large size. When this refrigerant is extracted, the accumulator ices up and prolongs the extraction process significantly.

An adapter may not be available for the new expansion valve design on the 2016 Jetta, Passat and Beetle. If not, drill open the expansion valve, use it as a connector during flushing, then replace it with a new one. Refer to ElsaPro or your service information for details on prepping and drilling open the TXV. Make sure the sealing surfaces are not damaged when drilling the TXV, or refrigerant will leak out during flushing.

You will need at least 7 kg (approximately 15 pounds) of R134a to completely flush an A/C system. Warm your refrigerant cylinder for 30 minutes prior to beginning the flush procedure. This increases pressure in the cylinder and accelerates the flush process.

Perform flushing according to the operating instructions of the A/C Service System. Plan to do at least three flush procedures. Depending on the type of contamination, dirt (old refrigerant oil and abraded material from the compressor) is deposited on the viewing glass(es). If the refrigerant oil from the flush process is black and viscous or there are many shavings in the refrigerant circuit, replace the filter in the flushing device. Clean the viewing glass and flush a fourth time to confirm that the A/C circuit is clean.

When done, check the pressure in the refrigerant circuit. There should be no positive pressure in the system. If there is, evacuate the refrigerant system briefly once more.

Vehicle and compressor manufacturers select air conditioning lubricants based primarily on their viscosity and lubricity, but there are a range of additional properties that make one oil a better choice for a specific A/C system application than another.

It is vital to choose the right oil for the job. Check the underhood label for the correct A/C system lubricant, and refer to ElsaPro or your service information for details if you are swapping one brand or model of compressor for another. It will help keep your customer cool, and your customer satisfaction high. ■

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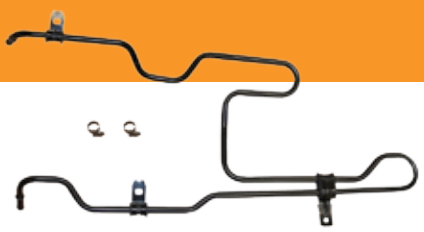

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