Volkswagen Tech Connect

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Volume 2 Number 1 Spring / Summer 2010

Clean Engine Management
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Electronic Throttle Operation
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The TPMS Valve Stem

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Cleaner Running.

Now, more than ever before, customers are concerned with the fuel mileage, performance and cost of ownership of their vehicles. Fuel mixture codes are definitely related, and are some of the most common codes we work on.

Fuel Mixture Codes

One of the most significant developments in automotive history was the introduction of feedback fuel systems. Electronic fuel injection had already been around for quite some time, but in 1976 Robert Bosch developed the oxygen sensor as the linchpin of the closed-loop principle. This allowed computer-controlled systems to monitor exhaust oxygen content, calculate a rich or lean mixture, and make changes to the amount of fuel injected into the engine. This resulted in a substantial reduction in harmful emissions and increased fuel economy. As with any automotive system, at some point it will require maintenance and/or repair. This is where we come in.

Never underestimate the visual inspection. Here we have a broken vacuum hose. This vacuum leak will lean out the mixture to a point of setting a code. Adding smoke to the intake manifold will help locate hard-to-find leaks.

Feedback systems have come a long way. They started with a single-wire, unheated 02 sensor, and now there are four- and five-wire sensors. Initially, there was only one sensor mounted in the exhaust stream, now there are typically two per cylinder bank. Also, there are other emissions controls that work with the engine management system. Exhaust Gas Recirculation, Canister Purge, and Positive Crankcase Ventilation systems all assist in reducing harmful emissions and add complexity. The more complex the system, the harder it is to diagnose when something goes wrong. What approach should you take when testing the emissions feedback system? When you see an O2 sensor lean code are you always going to replace the sensor?

The Symptoms

There are two situations where you will need to diagnose the emissions feedback system. Number one would be a DTC, and the second would be a drivability problem. A DTC means the powertrain control unit has monitored the feedback system and has determined that there is a problem. If the problem is severe enough, this can lead to a performance complaint. It's your job to figure out the cause of the symptom. In the case of DTC, you can follow the Guided Fault Finding charts. These are found in your VAG 5052 scan tool. You can still test components and diagnose a vehicle without the factory scan tool, but it will probably be more time consuming.

Look at the voltage specs on this 2.0 liter engine. The average and current signal voltage is around 1.3 volts. Look at the maximum voltage. It is only 3.5 volts after a throttle snap. If everything else is okay, you may need to replace it with an OEM sensor from your Volkswagen parts supplier.

When dealing with fuel trim codes such as P017X and P0112X, you can evaluate scan tool data, perform electrical component checks, and, of course, basic engine tests. One of the best ways to get started is to evaluate scan tool data. This is a huge step toward identifying where the problem is. Either with your VAG 5052, or your aftermarket equivalent, you can select "Read Measuring Blocks" and start looking at data. Select data blocks 030 to 039 on most Volkswagen vehicles and you will see fuel trim data. On most vehicles, data block 032 is an important one. This offers what is called "Additive" and "Multiplicative" fuel trim data. This data block number may change by year and model. A paid subscription to ERWIN allows you access to service information to identify the proper value block.

Fuel Trims Explained

As an engine is operating, the PCM is evaluating various inputs such at coolant temperature, throttle position and mass airflow. The PCM determines a base injector pulse width to add the right amount of fuel to the engine. If combustion is normal, a conventional oxygen sensor should read a stoichiometric mixture, aka Lambda, and maintain the injector pulse width and ignition timing. If the oxygen sensors pick up a rich condition (excessive fuel), or lean condition (insufficient fuel), it will report back to the PCM. The PCM will make the necessary changes to the mixture by altering the injector pulse width and/or ignition timing. The PCM can tell us the changes that it makes to get the engine emissions compliant.

These adaptations or changes are referred to as Fuel Trims. Trimming the air/fuel mixture corrects problems that may have come up during engine operation as components wear. If the changes are small, there is no problem and you will not set a code. However, there is a limit to how much the computer will change the mixture. If the Federally-mandated limit is exceeded by 1.5 times the norm, the computer is required to turn on the Check Engine Light, a.k.a. Malfunction Indicator Lamp (MIL), and flag a code for this condition. This is when the vehicle is no longer emissions compliant with EPA standards. Most of us are used to interpreting Long Term and Short Term fuel trim readings. Long Term would be the fuel adaptations over a longer period of time and short term readings would be immediate changes in fuel trim. You can find these numbers when scanning the vehicle using the Generic OBD II protocol and looking under "Data."

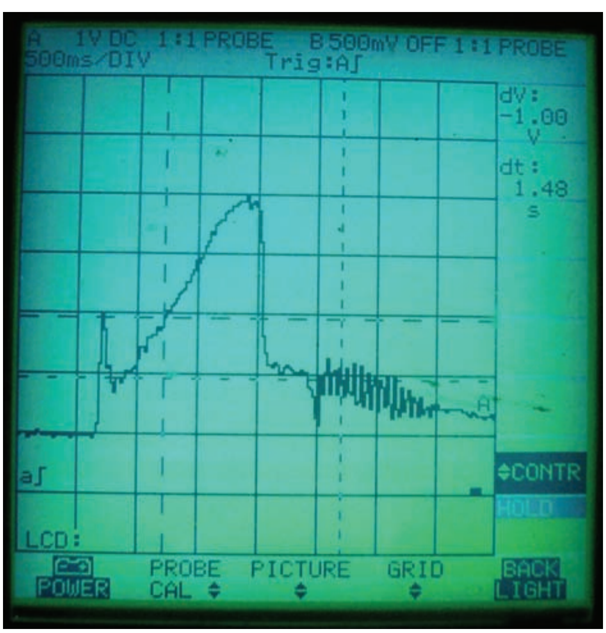
With a new MAF from your Volkswagen dealer's parts department you see a difference in peak signal voltage after a throttle snap almost reaching 3.9 volts. This is good for the 2.0 liter engine. Other engines may have different specs.

Volkswagen does not use the same scale as the Generic OBD II protocol. Volkswagen-specific software organizes fuel trim into two scales. They are called additive and multiplicative scales. The additive fuel trim occurs all the time. The changes made are at idle and throughout the rpm range. The fuel trim readings have a greater effect in the lower rpm range, at idle, and just off idle. Multiplicative readings only represent the fuel trims above idle and the higher part of the rpm range. This means the fuel trims will change when the vehicle is being driven around city streets and on the highway. Getting back to the measuring blocks, the fuel trim numbers are displayed in the 03X range. Most vehicles produced after 2000 display the additive and multiplicative numbers in data block 032. Field 1 shows the additive fuel trim and field 2 displays the multiplicative fuel trim on single bank engines.

With the VAG 5052, fuel trim readings are displayed in milliseconds. Positive milliseconds means the injectors are being kept open longer. Negative milliseconds means the PCM is closing the injector sooner. With aftermarket scan tools, the scales may change. Some display these readings with a scale based on Lambda, or the number 1.00. This means the number 1.00 is our midpoint or stoichiometric reading. If the number were to go above one, then the PCM is adding fuel to correct for the lean mixture. If the reading is below 1.00, then the PCM is subtracting fuel to compensate for a rich condition. Percentages can also be used to display changes in fuel trim. Here 0% is usually the midpoint. Above 0% is adding fuel and negative 0% means fuel is being subtracted.

How Do I Use This Information?

So, the additive fuel trim number tells us what the PCM is doing at idle, and the multiplicative number tell us what the PCM is doing at part throttle. When you first pull the fuel mixture codes, you need to look at these numbers to determine where the problem is. If you see the additive number has changed, you know the problem is mostly at idle, and this is where you should be performing your tests. If the multiplicative number has changed a lot, then the problem is more at part throttle, or while driving. Of course, different combinations will steer you along different diagnostic paths, so it is important to look at these numbers if you can.

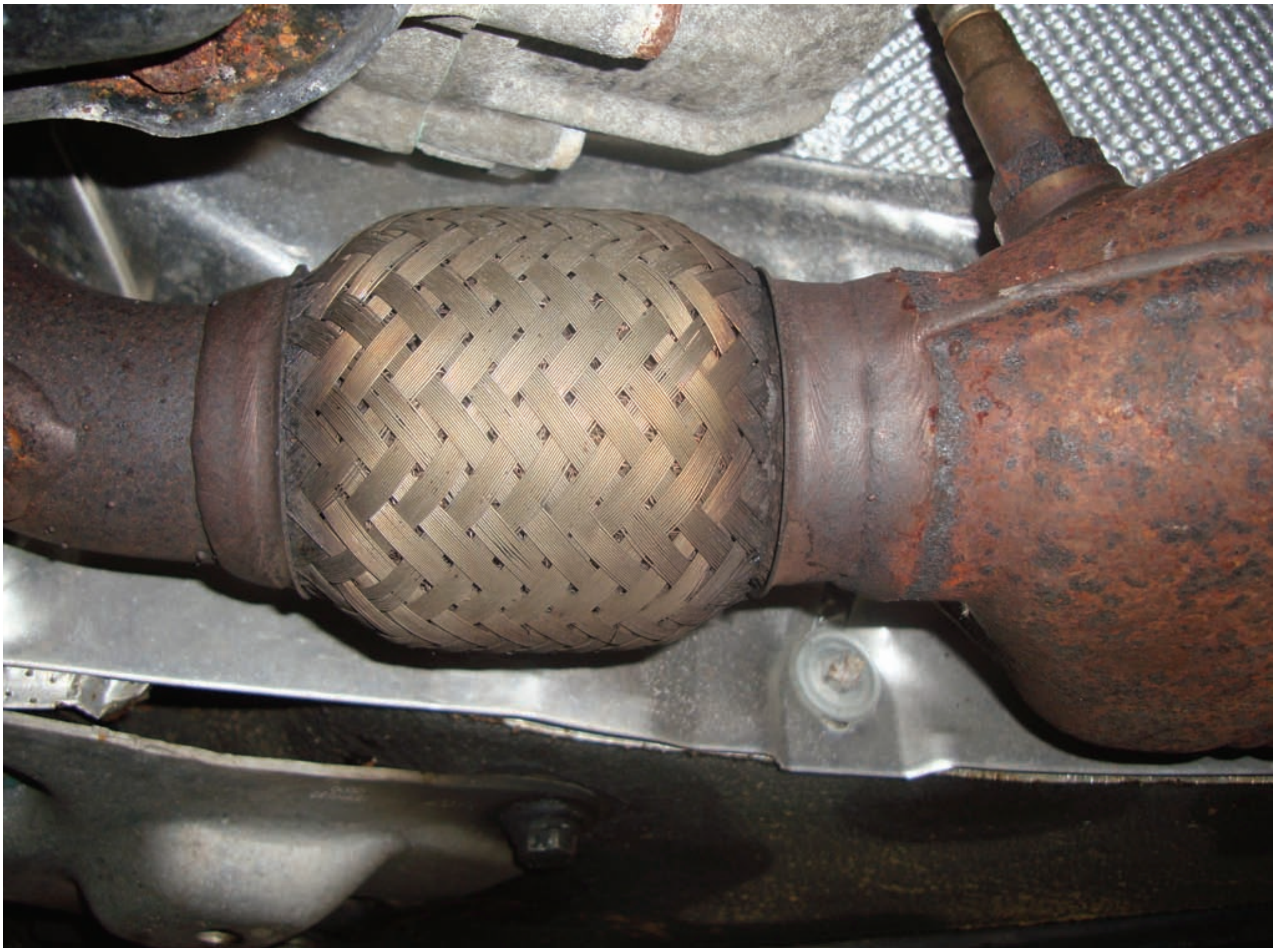


Here is a scope pattern of a 1.8L turbo MAF. The first spike to three volts is the snap of the throttle. The second spike up to over four volts is when the engine revs to 4,000 rpm. This MAF is not creating any fuel trim problems.

There are some symptoms that are a result of common problems. For instance, if you have a vehicle with high additive numbers, but the multiplicative is normal, you are probably dealing with a vacuum leak. This has more of an effect on mixture when the airflow is low than when the airflow is high. Check for broken vacuum hoses for the fuel pressure regulator, secondary air, and canister purge systems. You should smoke test the intake manifold and its plumbing to look for external vacuum leaks. You may also have internal vacuum leaks. Look to see if you have a code for incorrect purge flow as this may be a stuck-open canister purge solenoid "leaning out" the mixture at idle. This is an example of an internal vacuum leak.

If you have a vehicle where the additive number appears normal, but the multiplicative is high, you need to watch fuel pump pressure and MAF performance. The engine may be starving for fuel at higher rpm. When testing fuel pressure, remember fuel volume is just as important. A clogged fuel filter will restrict fuel flow to the engine. When testing the MAF, remember that if the air intake system has restrictions, you may get false low readings. Check the air filter and snow screens for debris that will restrict airflow. If the fuel pressure/volume tests pass and there are no airflow restrictions, you can now test the MAF. You can do this by monitoring the signal voltage while the vehicle is running, but how?

You can perform this test with either a digital multi-meter (DMM), or an oscilloscope. You will need to have some experience determining what a good voltage reading is for each engine type. For instance, the 1.8 liter turbo motor can have either a four- or five-wire MAF, depending on the engine designation. The signal wire typically puts out 1.3 volts when everything is normal. This is an indication that you have a good MAF. Next, turn on the MAX/MIN feature of your meter, which setting captures the maximum and minimum voltages sensed by the meter. Open the throttle as fast as you can to get the engine to rev to between 3,000 and 4,000 rpm. The rev limiter will prevent



When testing O2 sensors, you need to make sure the exhaust system is sealed. Here we have a leaking flex joint. This allows fresh air into the exhaust, which affects the O2 sensor signal. Use a smoke machine to check for leaks in the exhaust system.

the rpm from causing engine damage, but you only need to bring the rpm up once to capture the peak voltage.

The maximum signal voltage should be over 4.0 volts. Usually, a MAF that produces these signal voltages is okay for the 1.8L engine. A 2.0L AEG motor may only peak out at 3.8 volts on a snap throttle. You can also use your scan tool to check the MAF. For instance, on a 2001 Jetta with the 1.8 liter turbo AWW motor measuring value block 002 will give you grams per second. You should measure between 2.0 to 4.5 gps at a hot idle with all accessories off. If not, always replace with an OEM MAF from your Volkswagen parts supplier. Aftermarket new or remanufactured sensors are not always properly calibrated for the different Volkswagen engines and have been known to set codes for a rich condition. You do not want a comeback due to an aftermarket MAF being installed.

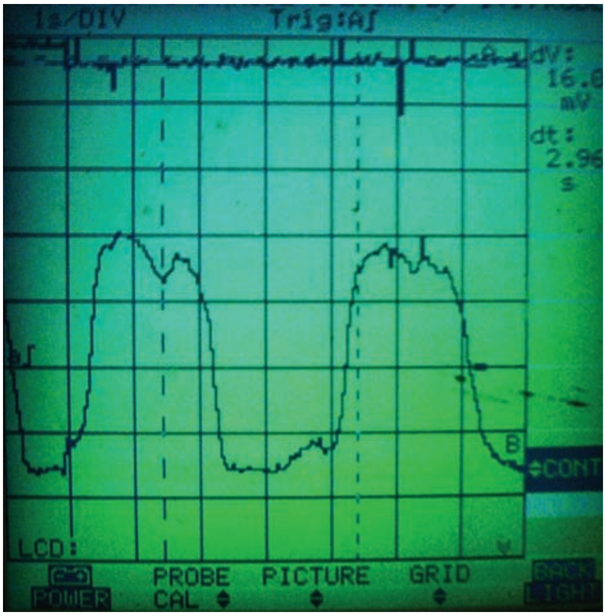
Other Factors

Of course, the O2 sensor has an important influence on mixture. But when you see a mixture code like P0171/4 or P1128, do not shoot the messenger. Test. If the engine is a V6, and you had mixture codes for both bank 1 and bank 2, you should suspect a vacuum leak or a bad MAF. If only one bank set a lean code, then you should suspect an O2 sensor. Once again, looking at measuring block 032 would give you the additive and multiplicative values for both banks. Fields 1 and 2 are additive and multiplicative for bank 1, and fields 3 and 4 are for bank 2 respectively. There is a chance you may have a vacuum leak at one of the intake manifold runners affecting only one bank. You are going to have to test something to determine if it is an injector, a vacuum leak, or an O2 sensor.

There are a few different ways to test an O2 sensor. On four-wire sensors, you can monitor the signal voltage with a scan tool, a DMM, or an oscilloscope. You can connect your DMM and watch the voltage change as the vehicle is idling. This voltage will continually change between 1.0 to 0.1 volts on a warmed-up sensor. A graphing multimeter will give you a visual graph of the voltage as it changes. An oscilloscope will give the best voltage pattern. You can look at the rise time and switch rate just as a PCM would monitor the signal. Typically, you should expect to see the O2 sensor signal switch from rich to lean at least once each second at idle. This means you have a good, working O2 sensor. If the switch rate is lower, or the signal voltage range is not above .8 volts and below .2 volts, then you will probably need to replace the 02 sensor with an OEM from your Volkswagen parts supplier. Make sure you have power and ground to the heater circuits.

The five-wire heated oxygen sensor (a.k.a. Air/Fuel Ratio) is harder to test with a DMM or scope. These sensors do not use a signal voltage to indicate a rich or a lean condition. Instead, they use an amperage signal to tell if it is rich or lean. You can tap into the pump cell to measure this amperage signal, but you will need to connect your ammeter is series. This means you must open the circuit to connect. Inductive ammeter probes do not measure low amperage signals accurately. This is a very low amperage, only switching between +5ma and -5ma. With these sensors, it is best to use the Volkswagen-capable scan tool.

Volkswagen does offer a way to test these types of O2 sensors (a.k.a. air/fuel ratio) using their factory-specific scan data. By entering “Basic Settings,” you can run tests on the various monitored systems. The component you want to test is the air/fuel ratio sensor. On most engine types,



When testing an O2 sensor waveform, look at the signal voltage's highest and lowest points. Also look at the total number of switches over time. You should see about one full switch per second. Volkswagen OEM O2 sensors will ensure performance to Volkswagen standards.

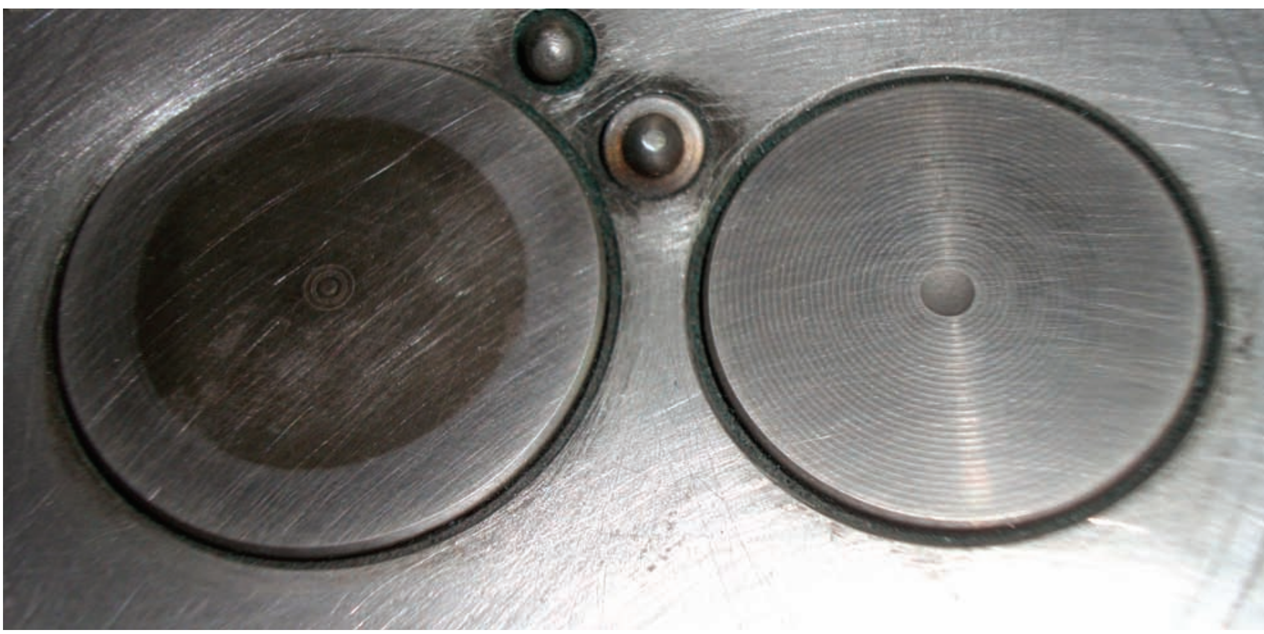
you can enter block 034 in Basic Settings. You will be instructed to rev the engine usually between 1,800 and 2,200 rpm for a few minutes. Look at field #4 and it will indicate if the air/fuel ratio sensor has passed or not. You can also perform this same test on a vehicle equipped with a conventional O2 sensor. Once again, you should get your Basic Settings block information from your paid subscription to https://erwin.vw.com.

In Conclusion

When diagnosing fuel trim codes, it’s best to use Volkswagen specific data. Once you have identified the rpm range, you can start testing. However, if you do not have this data available you can still check basics. The importance of checking fuel pressure, smoking the intake system, and testing basic engine operation cannot be overlooked. If the problem lies in the engine management system, you can start testing MAFs, oxygen sensors and blocking off auxiliary emission systems. Getting to the root of the problem and fixing the vehicle the first time is what all of us are after.

Diesels— Not What You Think!

Most people think of diesels as loud, smelly, and underpowered. Not anymore. Volkswagen has been refining and re-engineering Rudolf Diesel's ingenious invention for almost half a century. Let's keep them running great for another 50 years.



TDI® engines use direct injection. High-pressure fuel is sprayed directly into the cylinder as the piston reaches TDC. This improves efficiency over previous pre-combustion chamber designs. The injector tip is between the two valves with the glow plug above it.

Volkswagen introduced its first diesel into the United States way back in 1978. Many of those early versions are still in use today, kept alive by enthusiasts who appreciate their reliability, fuel economy and driving performance. They are obviously a wise automotive choice in today's current economic and environmental conditions.

Volkswagen started to do major upgrades on its diesel engines for the 1993 model year with the introduction of the AAZ 1.9L turbo. Additional engines were developed, such as the 1Z turbo in 1996, and the AHU and AHH in '97. The 1999 model year brought us the ALH motor that stayed in service until 2004. All of these are 1.9L turbos.

In 2004, the more highly-evolved BEW, BRM, and BKW engines were introduced, and in 2005 the BHW was released. These engines are all turbocharged 1.9L fours -- except the BKW, which is the 5.0L 10-cylinder diesel offered in the Touareg. In 2006, the BKW motor was improved and renamed the BWF. Finally, in 2008 the latest 5.0L V10 motor was dubbed the CBWA.

With proper maintenance, a Volkswagen diesel engine can easily exceed 250,000 miles in it's lifetime. The higher the mileage, the more maintenance and repairs these engines will need. You should be able to keep them running well with proper care and access to the factory diagnostic procedures. We will focus on the popular ALH engine here, but most of this information can be applied to other Volkswagen diesel systems as well.

Fuel Supply

Part of the success of Volkswagen's diesel systems is simplicity. There is no fuel pump inside or outside of the fuel tank. Look under the passenger side of the rear seat and you can remove the inspection cover. There is a filter screen, pick-up tube, and sending unit inside the tank. The fuel lines lead directly to the fuel filter, which is mounted under the hood by the passenger side inner fender. There is a bleed screw on the top of the filter to either fill with diesel fuel, or bleed out air in the system. Although Volkswagen recommends that the filter should be replaced every 20,000 miles under normal service, many service experts in the field suggest that you replace it at least once a year. Most of your customers drive these vehicles under severe service conditions. This means a lot of stop-and-go, and excessive idling. In addition, diesel fuel blends are changing all the time with new government regulations. Additives used to lubricate internal components can build up and solidify in the filter with every drive cycle, possibly slowing fuel flow. An OEM fuel filter provides the necessary quality to protect the diesel injector pump and the most resistance to clogging.

How does fuel get from the tank to the engine? The diesel injector pump has a rotary vane-type suction pump built into it that draws in fuel from the filter. This is why it is so important to have an unclogged filter. The vacuum generated should be enough to pull fuel from the tank without any assistance. If you are worried about a clogged supply line, you can run your own line to the pump from a can of clean diesel fuel. You are bypassing the screen in the tank and the fuel filter, so make sure the fluid is free of debris. Another way to test the pump is to put a vacuum gauge on the fuel inlet port and see how many in. Hg are generated while trying to start the engine. You should see over 10 in. Hg while cranking.

The fuel shut-off solenoid has a single wire to provide power. The body of the unit is the ground path. This solenoid is activated whenever the key is turned on. An anti-theft situation will turn off the solenoid, so monitor anti-theft data usually found in the instrument cluster, or immobilizer unit.

This test lets you know the pump is strong enough to provide a steady supply of fuel for the pressure side of the pump.

First Things First

Before the fuel can get to the pressure side of the pump, it must first pass through the fuel cut-off valve. This solenoid is mounted toward the back of the injection pump, underneath the fuel return line. It has a single wire bolted to the top of it. This wire provides battery voltage to the solenoid, which opens the valve to allow fuel to flow. The power comes from the Diesel Direct Fuel Injection (DFI) module, a.k.a. the Powertrain Control Module (PCM) as long as conditions are correct. With the ignition key on, the solenoid should be energized. The engine

When checking basic injector pump timing, be sure the crankshaft is at TDC. Look through the opening in the bellhousing and you should see an "0" mark. Line up the mark with the lower edge of the opening and check the pump timing.

does not need to be cranking or running. If it is not being energized, you need to check the power and ground supplies to the PCM.

Another input that can stop the PCM from activating the solenoid is the anti-theft system. If this does not like the transponder signal from the key, it will signal the PCM to "not" open the valve. You will have to look at data in the instrument cluster to determine if the anti-theft system is blocking the engine from starting. With a factory scan tool, you can perform an anti-theft system key alignment. This can be handled through any Volkswagen dealer's tool rental and Immobilizer Information program.

Things Are Going Well

If the fuel supply system is functioning properly and the fuel-cut solenoid is letting fuel into the high-pressure injector pump, it can now start running, right? Wrong. There are several components of the injector pump that need to work together. The drive pulley spins a shaft in the injector pump. As this shaft rotates, it creates high pressure. As this pressure passes the injector ports, the fuel is directed to the correct injector in the firing order. As well as base timing, the TDI Electronic Control Unit (ECU) can control injection timing to a small degree. It is also in total control of how much fuel will be delivered. These two readings are known as "Start of Injection Timing" and "Fuel Quantity" on your scan tool. Before you look here, you should check some basics.

Setting up base timing is, of course, critical to getting the engine started. This is performed with some special tools to lock down the camshaft and injection pump while the engine is positioned at TDC. This procedure will need to be performed if any of the timing belt components are replaced. First, you will need to turn the crankshaft to TDC. The mark to indicate TDC is in the oblong opening in the transmission bellhousing. Look for the "0" mark and line it up with the bottom edge of the opening. Now that the crankshaft is at TDC, you may as well line up the camshaft. Insert special tool VW #T10098 into the back of the camshaft with the valve cover off. You may have to remove a vacuum pump, if fitted.

Now that you have the crank and cam lined up, you can work on the injection pump. One of the slots in the pump gear has an opening that passes through the pump flange. Rotate the drive gear until this opening is at the 12 o'clock position. Then, insert special tool VW #3359 to lock the injection pump at TDC. You can now complete the timing belt installation. This level of timing will allow you to start the vehicle, but you may not have optimal performance. You may need to adjust the start-of-injection timing while the engine is running to get the best performance possible.

For this step, you must have a VAG5052, or equivalent, and monitor a few specific measuring value blocks. Injection timing is affected by several inputs. You must know these input values so that you can calculate what range the injection timing should be in. Look at measuring value block 000 and you will see 10 fields displaying information. The start-of-injection reading is in field #2. You will also need to watch coolant temperature. This reading is found in display field #7. Finally, you have to watch fuel temperature, which is found in display field #9. You need to watch all these

When checking alignment at TDC, the slot in the flange is at the 12 o'clock position relative to the pump. Here is where you put the special tool through the pulley into the hole pictured here in the injection pump. Using a genuine Volkswagen timing belt will help ensure both proper valve and injection timing, and long life.

inputs while the engine is running. Compare the inputs to the start-of-injection chart and see if the timing is within the proper range. If not, some adjustment is necessary.

You must shut off the engine to make the adjustment. On the pulley of the injection pump, you will see a 22mm center bolt surrounded by three bolts that attach the pulley. The bolt holes are slotted, so there is some adjustment available when the bolts are loose. You can rotate the 22mm bolt that is threaded into the injection pump shaft, which changes the timing. Rotate the shaft counterclockwise to retard the timing and clockwise to advance. The gear will be held in place by the timing belt. Tighten the pulley bolts and restart the engine. Look at field #2 and see if you are between the upper and lower limits on the chart. If you are, no further adjustment is needed.

The computer detects the start-of-injection timing from the crankshaft and camshaft position sensors. The cam sensor is mounted in the #3 injector. When fuel is sent to the injector, an electrical pulse is sent to the PCM. You should make only very small adjustments at the pulley because small adjustments will result in large changes in start-of-injection timing. Also, an important point to remember is that the readings in fields #7 and #9 are not direct temperature readings. So, a reading of 75 is not 75 deg. C. For instance, a reading of 73 in field #7 means the engine coolant temperature is 85 deg. C. The fuel temperature reading should be between 50 and 210 in field #9 to perform this test. If is not within this range, you will have to either let the engine warm up or cool off.

The Computer Takes Over

How is the injection timing controlled? Inside the injection pump, a cam plate is mounted around the fuel distribution shaft. This is held in position by both spring and fuel pressure. An injection timing piston uses fuel psi to move the

Scan data is still a great way to start off a diagnosis. When it comes to testing the electrical/electronic controls, a VAG1598 breakout box allows you to directly monitor the electrical signals to and from the PCM. This is a big help since many components are mounted inside the pump.

Looking at the pump harness, you will see that one plug supplies all of the electrical components. The lower harness goes to the cold start injector. The upper harness goes to the fuel shut-off solenoid and the quantity adjuster (left). The position sensor and fuel temperature sensor are mounted inside the pump.

cam plate into the base or advanced position. The amount of advance can be up to five degrees. A component known as the "Cold Start Injector" controls how much fuel pressure is applied to either side of the injection timing piston. The PCM controls the cold start injector, either opening or closing it depending on rpm, temperature, load, etc. It only controls injection timing below 2,200 rpm. You can monitor the amount of advance with your VAD 5051/2/4 in either measured value block 004 or 005 for the ALH motor. Controlling the advance properly reduces HC emissions and noise, and increases fuel economy.

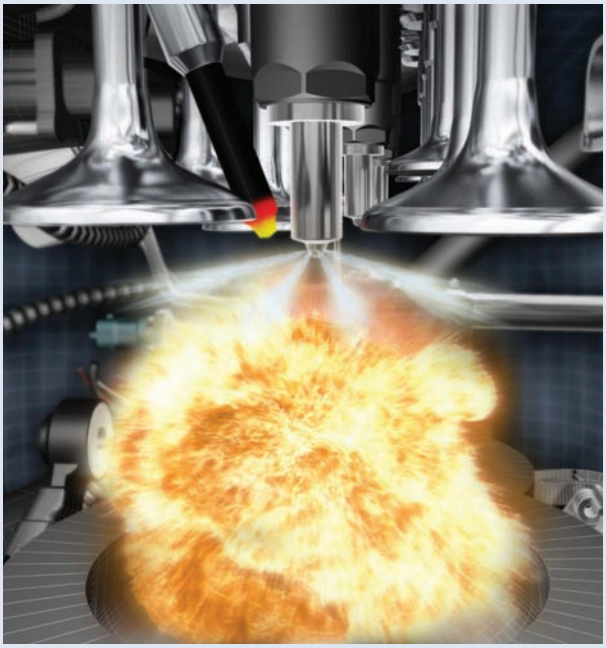
The second computer control has a bigger impact on fuel delivery. The PCM controls a "Quantity Adjuster" to increase or reduce the fuel delivered to the engine. This device moves a metering sleeve between the primary plunger and a spill port. If the metering sleeve blocks off the spill port passage, maximum fuel pressure is achieved. If the sleeve is commanded to open, all fuel pressure is directed to the spill port resulting in no pressure at the injectors. The adjuster can vary the pressure anywhere in between, and its position is monitored by a sensor in the injector pump itself. An AC pulse generated wave is sent to two resistor boards. The adjuster rotates on one board and the other remains fixed. One AC voltage remains steady and the other increases when the adjuster changes position. You can watch this signal with a lab scope, but looking at scan tool data will probably be a better indicator of the quantity adjuster position.

In Conclusion

As highly-evolved as it is, a Volkswagen diesel injector pump is still basically a pump. If any drivability problems arise, the base timing must be checked. Beyond that, the computer controls that advance injection timing and increase and decrease the injection pulse must be investigated since they can have a significant effect on drivability. Knowing how they function is half the battle.

Volkswagen's Original TDI® Engine.

The biggest boost to diesel popularity in the U.S. was this praiseworthy engineering effort.



Direct injection increases fuel efficiency by up to 20% over the use of pre-combustion chambers.

Wolfsburg's four-cylinder diesel engine, which first appeared here in 1978, has always had the respect of the mechanically inclined. It just kept going and going, all the while providing fuel economy that gasoline engines simply couldn't approach by virtue of their very nature.

But since its engine management was purely mechanical and it used pre-combustion chambers, its emissions and noise levels were too high, and its performance and fuel efficiency too low to make it acceptable in more modern times.

VW continued to believe in the viability of the diesel, however, and figured its problems could be vastly mitigated. The result of this thinking was the TDI® 1.9L diesel engine, which was first available here in the 1996 Jetta, Passat and Golf models and offered excellent fuel efficiency along with spirited acceleration.

This transformation was accomplished through the application of thoroughly modern technology beginning with electronically-controlled injection, boost, EGR, and glow plug on-time. The computer gets the info it needs from numerous sensors, including those for MAF, MAP, ECT, TP, IAT, and fuel temperature, then decides which of 25 maps is appropriate.

The TDI® engine gets a big increase in efficiency from direct injection, as was previously seen only on heavy-duty diesels. The electronics allow fuel to be force-fed straight into the combustion chamber in two stages, which softens operation. A unique inlet swirl port and five-hole injectors that make a nice mist contribute, too. By the way, diesel injection pump outlet pressures are always high, but those of the TDI® engines are especially so -- nearing 1,500 psi (100 BAR).

Another smoothness enhancement is the intake manifold flap. In any diesel engine, compression is so high that it tends to stop the pistons abruptly during shut-down, which causes an unpleasant shudder. This vacuum-operated flap cuts off intake air upon command from the PCM, thus lowering psi and allowing a kinder, gentler finish.

You may not expect to see a catalytic converter on a diesel, but the TDI® engine has one. While it helps a little on HC and CO, its big job is knocking down NOx. Speaking of NOx, the EGR includes a cooler to reduce the temperature of the recycled gases, which helps its efficiency.

The timing belt replacement interval is every 40K miles. This is definitely a hitter, so you'd better keep after your customers about this job as a way to avoid megabuck repairs. Just as in the original Rabbit diesel, a special tool is available to lock the injection pump hub in place while you R&R the belt (a setting bar holds the cam). Never, ever loosen or remove the hub from the pump shaft.

Throttling away.

In 1996, Volkswagen introduced an electronic throttle on the AAA V6. Integrating this with traction control, cruise control, and idle speed control makes for a safer vehicle. Keeping the system working properly is our job.

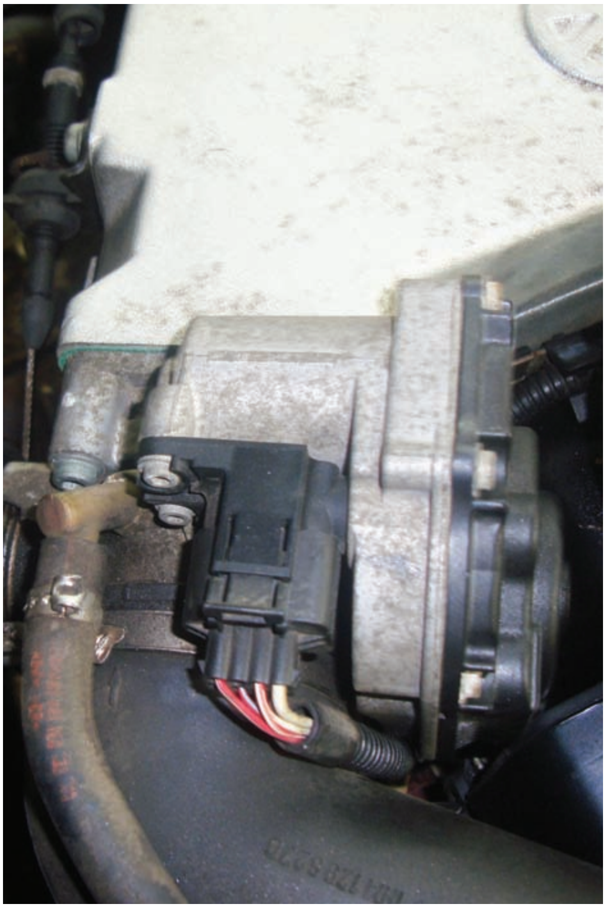
Electronic Throttle

Believe it or not, fly-by-wire systems have been used on passenger vehicles for almost 20 years. For the driver, there's no change in the way the car feels. The benefits are at an engineering level. An idle speed motor is no longer needed. All the electronic engine management system has to do is open and close the throttle plate to adjust engine rpm. Without mechanical throttle linkage, cable-operated cruise control can't be used. That's okay, though, because the Powertrain Control Module (PCM) just has to command the throttle plate to maintain the desired speed.

With traction control, it gets more interesting. Let's say the amount the throttle is opened suddenly causes the wheels to start spinning. The driver could possibly go into a skid, or spin. With the traction control, computer and the PCM working together, the throttle can be automatically closed until traction is regained. Also, no longer do we have to worry about sticking or broken throttle cables. The benefits clearly outweigh the additional complexity of the system. But what do we do when something goes wrong?

If you want to diagnose something, it helps if you know how it's supposed to work. Volkswagen has used a few variations of electronic throttle over the years, so it's best to be familiar with the changes. Earlier models use an electronic throttle module, but it still have a throttle cable for the ME5.X system. The cable mechanically opens and closes the throttle for typical city and highway driving. The electric motor in the throttle assembly only controls low rpm and idle situations. There is a Throttle Position Sensor (TPS) attached to the cable, which relays throttle requests from the driver. A second TPS indicates the position of the throttle motor. This is how adjustments are made to better control idle-speed situations. The two voltages are monitored by the computer and compared. If the control unit does not like one of the signal voltages, it can stop throttle control and flag a code.

Over time, the throttle plates can cake up with carbon. This reduces the idle speed of the engine. The PCM can see this rpm drop and command the throttle plate to open slightly more until the proper idle speed is reached. There are limits for this compensation, however. If the PCM has to add too much air, it will flag a code and turn on the Malfunction Indicator Lamp (MIL, aka CEL for Check Engine Light). At this point, you need to clean the throttle plates and restore a normal idle. It's important that you do this right: Never spray cleaning solution into the throttle bore. With all the different carbon cleaners on the market, there is no safe way to predict if what you're using will damage the internal components unless you purchase a Volkswagen recommended throttle body cleaner from your local dealer. Then, spray the solution on a clean rag and wipe any carbon build-up out of the bore and off the plates. This will help prevent any cleaning solution from making its way into the electronics.



If you see a cable on the throttle body, you'll know this is a ME5 system. The electronic throttle only controls idle speed and low rpm functions. The throttle will have to be re-adapted if you get a code P1580 or P1582.

Over time, carbon and oil can build up around the throttle plate. This will reduce the flow of air and reduce idle speed. The PCM can compensate by opening the throttle more. When the idle adaptation is lost, low idle and decel stalls may result.

If the problem is severe enough, you may have to perform a throttle adaptation. This may also have to be done if the battery has gone flat or been disconnected. You can do this with a VAG 5052 from the "Basic Settings" menu. Look for the proper three-digit code under repair information at www.erwin.vw.com. The numbers are typically 060 or 098, depending on year and model. What this procedure does is align the throttle assembly with the PCM. Typically, this has to be performed if you get Diagnostic Trouble Code (DTC) P1580, or P1582. Just clearing the code may not keep the light off. During the adaptation, you will notice one of the TPS signal voltages change, and in field #4 you should see the message "Adapt OK" when it is completed. If the adaptation fails, the first thing you should check is battery voltage. It must be above 12V to perform the adaptation. If it is, you may have a problem in the throttle module.

To test the throttle module, you can start with a quick scan of the voltages using your VAG. You can select "Read Measuring Value" block 060, or 098 to see the position sensors. They may be displayed in either voltages or throttle angles. Do not assume that the throttle body needs to be replaced if the readings are not correct. You should always support your diagnostic tests with actual voltage readings from a Digital Multi-Meter (DMM), or lab scope. Verify that the five-volt reference and ground are good, and check electrical connections. Fluctuating voltages from poor connections can lead to an incorrect diagnosis and a comeback. For instance, on the 1998 1.8L Turbo AEB engine you have an eight-pin connector for the throttle module. The pin layout is as follows:

1. Throttle motor positive supply
2. Throttle motor negative ground
3. Idle switch
4. Five-volt reference
5. Position signal driver input
6. Empty
7. Sensor ground
8. Position signal throttle motor

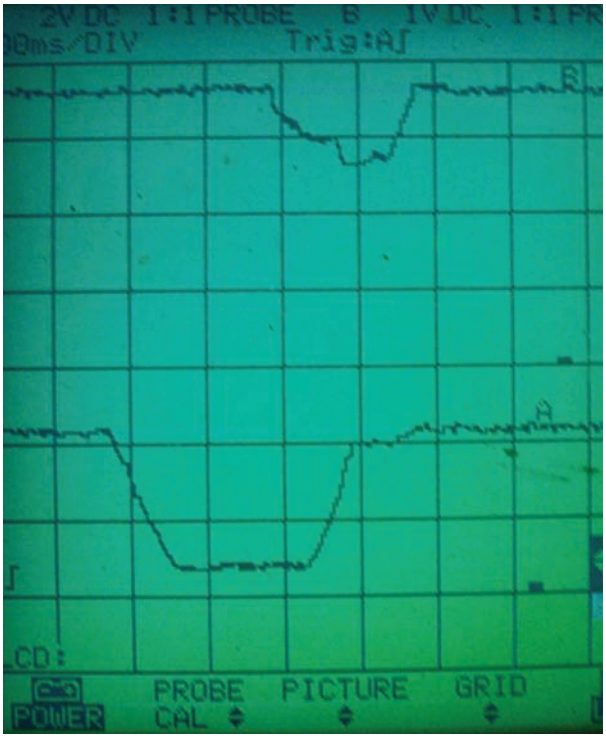
Notice the gold-plated terminals for a better electrical connection. The terminals are numbered differently from what you might assume. Here, terminal 1 is in the lower left hand corner, and terminal 2 is in the upper left hand corner -- they power and ground the motor.

If the connector is unplugged, the throttle assembly defaults to a partially open position. The engine should rev to somewhere between 1,200 and 1,300 rpm, and, of course, codes will be flagged. With the control unit functioning normally, the idle speed should be about 900 rpm. You can monitor other measured value blocks to help determine what the problem may be. If you suspect a dirty throttle bore, search for idle adaptation values in your service information. This displays how much the PCM is opening the throttle to compensate for the low idle speed. If you have a vacuum leak, the computer may attempt to close the throttle to reduce the idle speed. This situation may also set additive lean system codes, so look for those as well.

Evolution

Volkswagen made a few changes on the ME 7.X systems, which make them true fly-by-wire. The cable has been eliminated, so the throttle plate is only opened by the motor. There are two throttle plate position sensors, which are opposites. With the plate closed, one sensor reads approximately .5 volt and the other should read about 4.5 volts. As the throttle plate is opened, the wire with .5 volt gradually increases toward 4.5 volts, and the wire with 4.5 volts decreases to roughly .5 volt. The PCM cross-checks these two voltages to verify "plausibility." If the voltages do not make sense, the computer will go into fail-safe and no longer open the throttle plate.

If the PCM detects a binding throttle plate, it will also go into fail-safe mode and flag a DTC. There is an accelerator pedal position sensor mounted on the pedal assembly, which supplies input on the driver's request. It also has two TPS signals that provide signal voltages to the PCM. These increase as the throttle is opened, but at different rates. The #2 TPS signal is about half the voltage of signal #1 as the pedal is depressed. Once again, if the PCM does not like the signal voltages as it compares them, it will go into fail-safe. There are a few failure modes depending on what has failed. We'll look at the different possibilities.



Here are the TPS signal voltages from a '97 ABA engine. Notice how the upper trace for the motor does not open that much with the vehicle revved in park. The lower trace is the TPS for the gas pedal.

Imagine the Possibilities

If a failure has been picked up by the self-diagnostic portion of the PCM, it will enter one of three failure modes. These fail-safes are referred to as Emergency Running Modes 1, 2, and 3. Mode 1 occurs when one of the throttle position sensors fails, and you will only have about 60% power. The PCM uses the properly-working TPS and the Mass Air Flow (MAF) sensor signals to cross-check one another while in this limited-power mode. A new addition is the Electronic Power Control (EPC) light in the dashboard. This lets the driver know that one of the emergency running modes is active. The MIL will also be activated.

If a fault has been found in the actual throttle motor, its power and ground supplies will be shut down. This is Emergency Mode 2. The throttle plate will default to its mechanical position of 1200 to 1300 rpm. Mode 3 is similar to Mode 2, but the PCM enters this mode when two TPS signals readings fail. You will not see any substitute values in the scan tool, so check the measuring blocks in the 06X range and you should see either throttle plate angle or signal voltages. If you want to scope the signal key-on/engine-off, you will not get the throttle open completely. The trick is to put the vehicle in gear, then apply the throttle. It should open completely, and you can test the full range of both TPS signals. There are no serviceable components either in the accelerator pedal position sensor or the throttle module. They both need to be replaced as an assembly.

If you still have intermittent codes for the throttle module, check this connector above the transmission. This engine harness contains the wiring for the throttle assembly. You may have corrosion on some of the terminals.

In Conclusion

Understanding how the electronic throttle functions and how it works with the PCM will reduce your diagnostic time and lead to more accurate troubleshooting. Try to point out that billable services such as throttle bore cleaning and resetting throttle adaptation are required for the system to function properly. If the customer enters one of the emergency running modes, inform him or her that these fail-safes provide for a safer driving experience, and who wouldn't want that?

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Where the rubber meets the road.

Occupant safety has always been the highest priority at Volkswagen. Tire Pressure Monitoring Systems support that by reducing the number of flat tires and preventing tire failure. They also improve tire life and MPG. Let's keep them working.

The expression is, "Where the rubber meets the road." It means we are dealing with something important. No matter how powerful an engine is, or how capable the brakes are, if the tires don't provide traction with the road it's all useless. Maintaining the vehicle's grip on the pavement is one of the most important parts of safe driving. So, anything that can compromise this is dangeous. Properly inflated tires are, naturally, part of the equation. They're designed to work best within a specific pressure range. If you're outside of these boundaries, you're looking for trouble.

Pneumatic tires rely on internal air pressure to maintain their shape while under the load of a vehicle. If pressure were to drop below specifications, the weight of the vehicle can cause the sidewalls to bow out too much at the bottom. As the tire rotates, toward the top the sidewalls straighten out. This flexing is a bad thing. It generates excessive heat, which, when coupled with the heat of road friction can surpass what the rubber and cords can handle. It can cause the cords to separate from the rubber, eventually leading to tire failure. A system had to be devised that could monitor air pressure so that this scenario could be prevented.

If you want to know if a vehicle has TPMS, look at the valve stem. If it has a silver retaining nut, it has the system. Set tire pressures to specs when the tires are cold.

Direct versus Indirect

The Department of Transportation and the National Highway Safety Administration have conducted studies of motor vehicle accidents. One of the major causes of these accidents is tire failure as a result of low inflation pressure. In an effort to reduce this, manufacturers were compelled to install Tire Pressure Monitoring Systems (TPMS) beginning in 2007 model year vehicles. These systems indicate to the driver if tire pressure is low in any of the road wheels, and in some cases even the spare. Two different types of systems are used. One is referred to as a direct sensor system. This has individual pressure sensors mounted inside the tires. They read tire pressure and send this information via a radio frequency signal to antennas mounted in the wheelwells.

The second system is called indirect TPMS, which Volkswagen will introduce in 2011 model year vehicles. It uses the wheel speed sensors of the ABS/Traction control systems to determine the circumference of the tire. If one tire wheel speed sensor signal indicates faster rotation than the other three, and the vehicle is not under acceleration, then the tire's diameter must be smaller. This can only be caused by low tire pressure. In either system, the actual tire pressure is shown in the driver information display, or a warning light is illuminated in the instrument cluster. This warns the driver to correct the tire pressure before there is a problem. When the tire pressure has been restored to specifications, the system will relearn the new pressure and turn off the light. This is easier said than done.

Starting in 2011 model year vehicles, you may see conventional valve stems on certain Volkswagen models. That's because the company will be switching to the indirect system that uses wheel speed sensors to detect underinflation. If this is present on an earlier model, the TPMS components have been removed, possibly by mistake.

Most Volkswagen vehicles use the direct sensor system. Each wheel has its own sensor to indicate the inflation pressure. In some models, four sensors are fitted to the road wheels, and there's no sensor in the spare. If you have a TPMS warning light that you can't clear, find out if the spare has been mounted to replace a flat tire. This could save hours of wasted diagnostic time. In other cases, a five-sensor system with a sensor in the spare is used. When correcting tire pressure, don't forget to check the spare as this might keep the light on. Also note the position of the spare tire. You want to keep the sensor as close to the antenna as possible. While these sensors don't last forever, they do have some of the latest battery technology in them.

The TPMS sensors of direct systems use lithium-ion batteries. They are designed to last 10 years under normal circumstances. When the ignition key is turned on, the TPMS system starts to monitor air pressure.

Here's the replacement sensor. It should last 10 years, but driving with a slow leak will constantly trigger the sensor to transmit the RF signal. This shortens battery life.

If everything is okay, the sensors go into a low-power mode. This helps conserve battery life. If the tire pressure drops, the sensor wakes up and starts to transmit. The antenna picks up the signal and sends it to the TPMS control module, which communicates this information to the instrument cluster through the CAN system. What does this mean to us? If the CAN is down, the information cannot be sent or received. If you are having trouble resetting the light, look for CAN codes and repair the problem.

In certain Toureg and Phaeton models, a separate TPMS control module (J502) is used. In Jetta models, the five TPMS sensors send their information to the Central Locking and Anti-Theft control module antenna. Through the CAN, these signals are sent to the TPMS module, which is housed inside either the J519 Body Control Module (2010 Jetta, Jetta sportwagen, GTI, Golf, and EOS), or the Comfort and Convenience module.

A sensor will start to transmit data with tire rotation and pressure drop. It won't begin to transmit with a pressure increase, so adding air will not activate the sensor. To get a sensor to transmit, you will need to drive the vehicle at over 16 mph after correcting the pressures. The tire pressure specs are on a placard taped inside the driver’s door "B" pillar. These are for cold inflation pressures.

When replacing components, there are some rules you need to follow to do the job right. If the TPMS control unit must be replaced, it will have to be coded to the vehicle. When tires are replaced, be careful not to strike the sensor, which is mounted to the valve stem. If your tire machine rotates counter-clockwise, you should start with the sensor to the left of the bead removal arm so it rotates away from it. During mounting, be sure not force the bead down on the sensor. Do not use any puncture seal or bead

When replacing the TPMS sensor, it is a good idea to replace the valve stem assembly. OEM level quality parts are available from an authorized Volkswagen dealer.

Aftermarket tools are available for testing TPMS sensors. You'll need to activate the sensor and set the tool to pick up a 315MHz signal. The display will let you know that the sensor is transmitting.

sealer while mounting a tire. You can use solid lubricant on the bead, which will not touch the sensor and interfere with its operation.

Remember, in the Jetta, the TPMS control unit is mounted in the Comfort & Convenience module. This will need to be coded to the vehicle if is replaced. On Toureg models, the tire sidewalls are thicker and stiffer, so a stronger RF signal sensor is used. You can tell the sensors apart by four white stars printed on the sensor itself. Even though the sensor battery is supposed to last 10 years, frequent low tire pressure driving will shorten its life. It's best to advise customers to fix whatever slow leak is present and not drive around with the light on for long periods of time. Also, let them know that proper inflation pressure will give them the best gas mileage.

There are several ways to find out if a sensor is functioning properly. The BRT-DBL4 is the Volkswagen factory tool that reads the sensors' RF signals (there is no VAG number on this tool). There are also aftermarket tools available that detect the frequency generated by the wheel speed sensors when they are transmitting. Simply lower the tire pressure by 6-7 psi and hold the tool against the sidewall closest to the valve stem. It should pick up the signals from the sensor. If not, the sensor may be dead. If any of the sensors have to be replaced, make sure the vehicle has been parked for at least 20 minutes, then driving it at more than 16 mph for seven minutes. The 20-minute wait puts the computer into learn mode. The sensors will transmit their identification numbers, air pressure, temperature, and wheel velocity. Volkswagen presently uses sensors that transmit at 315Mhz.

Finally . . .

Although many techs have complained about the complexities of TPMS systems, they are really not that difficult. An authorized Volkswagen dealer's parts department can provide you with OEM valve stems, wheel sensors, antennas, and control units that are engineered for the vehicle, giving you the peace of mind of knowing the job was done right.

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(847) 570-3081

Glenview
Jennings Volkswagen
(847) 729-3500

Gurnee
Gurnee Volkswagen
(847) 855-1500

Highland Park
North Shore Volkswagen
(847) 433-7900

Joliet
D'Arcy Volkswagen
(815) 725-5200

Libertyville
Liberty Import Center
(847) 680-8000

Mt. Prospect
Autobarn VW of Mt. Prospect
(888)744-3820

Naperville
Bill Jacobs Volkswagen
(800) 519-4879

Normal
Sud's Volkswagen
(800) 345-1679

Oak Lawn
Mike Haggerty Volkswagen
(708) 425-8989

O'Fallon
Auffenberg Volkswagen
(618) 622-4645

Orland Park
Volkswagen of Orland Park
(708) 428-5000

Ottawa
Sierra Volkswagen
(815) 433-1666

Peoria
Volkswagen of Peoria
(309) 243-1101

Rockford
Lou Bachrodt Volkswagen
(815) 332-3001

Schaumburg
Fox Valley VW Schaumburg
(224)353-2481

Springfield
Green On Dirksen
(217) 523-3643

Urbana
O'Brien Volkswagen
(800) 386-6767

West Chicago
Fox Valley Volkswagen
(630) 818-4181

Indiana

Bloomington
Royal VW of Bloomington
(812) 332-9251

Clarksville
Clapp Volkswgen
(812) 948-1541

Evansville
D-Patrick, Inc.
(812) 473-6500

Fort Wayne
Vorderman Volkswagen
(260) 969-6065

Greenwood
Dreyer & Reinbold /Greenwood
(317) 885-4809

Indianapolis
Falcone Volkswagen
(317) 263-0002

Indianapolis
Tom Wood Volkswagen
(317) 688-6109

Lafayette
Mike Raisor Imports
(765) 447-0808

Merrillville
Team Volkswagen
(888) 805-3689

Mishawaka
Gurley Leep Imports
(574) 254-7130

Iowa

Cedar Falls
Dick Witham Volkswagen
(319) 277-8123

Davenport
Volkswagen of Quad Cities
(563) 386-1511

Hiawatha
Volkswagen of Cedar Rapids
(319) 743-6050

Iowa City
Carousel Motors
(319) 354-2550

Johnston
Lithia VW of Des Moines
(515) 253-0333

Mason City
Schukei Volkswagen
(641) 423-5402

Kansas

Lawrence
Jim Clark Motors
(785) 843-3055

Olathe
Bud Brown Volkswagen
(913) 393-8183

Topeka
Sunflower Motors.
(785) 266-8480

Wichita
Steven Volkswagen
(316) 681-1211

Florence
Kerry Volkswagen
(859) 371-8191

Kentucky

Lexington
Don Jacobs Volkswagen
(859) 260-2621

Louisville
Bachman Volkswagen
(502) 719-7250

Louisville
Neil Huffman Volkswagen
(502) 448-6666

Louisiana

Baton Rouge
Southpoint Volkswagen
(800) 291-0032

Bossier City
Moffitt Volkswagen
(318) 746-2175

Lafayette
Southwest Volkswagen
(337) 456-7535

Mandeville
Northshore Volkswagen
(985) 626-1067

Metairie
Walker Volkswagen
(504) 465-2000

Maine

Auburn
Rowe Volkswagen
(207) 784-2321

Augusta
O'Connor Volkswagen
(207) 622-6336

Bangor
Darling's
(207) 941-1330

Brunswick
Morong Brunswick
(207) 725-4323

Falmouth
Morong Falmouth Volkswagen
(207) 781-4020

Saco
Prime Volkswagen
(207) 283-2900

Waterville
Thompson Volkswagen
(207) 873-0777

Maryland

Annapolis
Fitzgerald Automall
(410) 224-3480

Baltimore
Heritage Volkswagen Parkville
(410) 661-3400

Baltimore
Russel Volkswagen
(410)744-2300

Cockeysville
Volkswagen of Hunt Valley
(410) 666-7777

College Park
DARCARS Volkswagen
(301) 441-8000

Fallston
Cook Volkswagen
(410) 877-1500

Frederick
Fitzgerald Volkswagen
(301) 696-9200

Gaithersburg
King Volkswagen
(240) 403-2300

Hagerstown
Sharrett Volkswagen
(301) 739-9999

Laurel
Ourisman Volkswagen of Laurel
(800) 288-6985

Owings Mills
Heritage Volkswagen
(410)581-6696

Volkswagen Dealers Listing

*Authorized Wholesale Mechanical Dealers shown in blue.

Pasadena
Antwerpen Volkswagen
(410) 553-0843

Rockville
Congressional Volkswagen
(301) 340-7668

Waldorf
Waldorf Volkswagen
(301) 843-8950

Massachusetts

Auburn
Patrick Motors
(800) 367-7222

Bedford
Minuteman Volkswagen
(781) 275-8000

Beverly
North Shore Volkswagen
(978) 927-6000

Braintree
Quirk Volkswagen
(781) 917-1537

Brockton
Paul Clark
(508) 587-9040

Fairhaven
Alden Volkswagen Fairhaven
(508) 999-3300

Fall River
Mattie Imports
(508) 678-5555

Hyannis
Tracy Volkswagen
(508) 775-3049

Lawrence
Commonwealth Volkswagen
(978) 687-3001

Medford
Colonial Volkswagen /Medford
(781) 475-5208

North Attleboro
Volkswagen of North Attleboro
(508) 695-0321

Northampton
Dana Automotive
(413) 584-1442

Norwood
Volkswagen Gallery
(800) 240-0382

Pittsfield
Flynn Volkswagen
(413) 443-4702

Tewksbury
Atamian Volkswagen
(978) 851-4356

Watertown
Boston Volkswagen
(617) 783-1300

Wellesley
Wellesley Volkswagen
(781) 237-3553

West Springfield
Fathers & Sons
(413) 737-7766

Westborough
Colonial Volkswagen
(508) 366-8383

Michigan

Ann Arbor
Howard Cooper Volkswagen
(888) 822-8707

Bay City
Thelen Volkswagen
(989) 684-2980

Escanaba
Halbinsel Volkswagen
(906) 789-9650

Farmington Hills
Suburban VW /Farmington Hills
(248) 471-0800

Grand Rapids
Betten Imports
(616) 301-2100

Grand Rapids
Gezon Volkswagen
(616) 361-7361

Holland
Crown Volkswagen
(616) 393-0400

Kalamazoo
Maple Hill Volkswagen
(269) 327-0816

Lansing
Williams Volkswagen
(800) 258-2853

Livonia
Ralph Thayer Volkswagen
(734) 425-5400

Monroe
Elite Volkswagen
(734) 242-3900

Muskegon
My Auto Import Center
(231) 799-2886

Rochester Hills
Fox Volkswagen
(248) 656-0400

Sterling Heights
Vyletel Volkswagen
(586) 276-4650

Traverse City
Traverse City Volkswagen
(231) 946-5540

Troy
Suburban Volkswagen
(248) 649-2074

Minnesota

Albert Lea
Dave Syverson Volkswagen
(507) 373-1438

Brainerd
Auto Import
(218) 829-3307

Burnsville
Burnsville Volkswagen
(952) 892-9470

Inver Grove Heights
Volkswagen of Inver Grove
(651) 204-4607

Mankato
Mankato Volkswagen
(507) 625-5641

Maplewood
Schmelz Countryside VW
(651) 484-0424

Rochester
Rochester Motors
(507) 282-9468

Saint Cloud
Eich Motor Company
(320) 251-1737

Saint Louis Park
Luther West Side Volkswagen
(952) 374-0700

Mississippi

D'Iberville
Mandal Volkswagen
(228) 392-6560

Jackson
Volkswagen of Jackson
(601) 368-3691

Missouri

Ballwin
The Dean Team of Ballwin
(636) 227-0100

Gladstone
Northtowne Volkswagen
(816) 436-2275

Hazelwood
Bommarito VW of Hazelwood
(314) 731-7777

Kansas City
Molle Volkswagen
(816) 941-9500

Kirkwood
The Dean Team of Kirkwood
(314) 966-0303

Springfield
Volkswagen of Springfield
(417) 886-6000

St Louis
Suntrup Volkswagen
(314) 892-7790

St. Peters
Bommarito VW of St. Peters
(636) 928-2300

Montana

Bozeman
Volkswagen of Bozeman
(406) 586-1771

Great Falls
Bennett Imports
(406) 791-2507

Missoula
4 Seasons Volkswagen
(406) 728-2516

Whitefish
DePratu Volkswagen
(406) 863-2520

Nebraska

La Vista
Performance Volkswagen
(402) 502-8671

Lincoln
Schworer Volkswagen
(402) 435-3300

Omaha
Stan Olsen Auto Center
(402) 397-8200

Nevada

Henderson
Findlay Volkswagen
(702) 558-6600

Las Vegas
Desert Volkswagen
(702) 942-4000

Reno
Lithia Volkswagen of Reno
(775) 851-5826

New Hampshire

Manchester
Quirk Volkswagen
(800) 842-9600

Greenland
Seacoast Volkswagen
(603) 436-6900

Keene
Noyes Volkswagen
(888) 355-2488

Lebanon
Miller Volkswagen
(603) 448-6363

Nashua
Tulley Volkswagen
(603) 888-0550

Rochester
Beranger Volkswagen
(603) 332-6242

Tilton
AutoServ Volkswagen
(800) 775-3141

New Jersey

Berndardsville
Bernardsville Volkswagen
(908) 766-1600

Burlington
Burlington Volkswagen
(609) 386-0084

Cape May Court House
Burke Brothers
(609) 463-4903

Cherry Hill
Cherry Hill Volkswagen
(856) 654-5660

Clifton
Gensinger Motors
(973) 778-8500

Edison
Reydel Volkswagen
(732) 287-2444

Englewood Cliffs
East Coast Volkswagen
(201) 568-0053

Fairlawn
Jack Daniels Motors
(201) 398-1209

Flemington
Flemington Volkswagen
(908) 782-2400

Freehold
Volkswagen of Freehold
(732) 339-6910

Hamilton Square
Hamilton Volkswagen
(800) 348-8816

Lyndhurst
Three County Volkswagen
(201) 933-6566

Monroeville
Avis Volkswagen
(856) 358-8103

Neptune
World Volkswagen
(732) 922-1500

Newton
Volkswagen of Newton
(800)842-0562

Pleasantville
Atlantic Volkswagen
(609) 646-8600

Pompton Plains
Crestmont Volkswagen
(973) 839-6444

Princeton
Princeton Volkswagen
(609) 921-6401

Ramsey
Joe Heidt Motors
(201) 327-2900

Rockaway
Trend Motors
(866) 44T-REND

Roselle
Linden Volkswagen
(908) 486-6201

Shrewsbury
Shrewsbury Motors
(732) 741-8500

Somerville
Millennium Volkswagen
(908) 685-1068

Summit
Douglas Motors
(800) 672-1172

Turnersville
Prestige Volkswagen
(856) 629-9200

New Mexico

Albuquerque
University Volkswagen
(505) 761-1900

Las Cruces
Sisbarro Autoworld
(575) 524-3561

Santa Fe
Premier Motorcars/Santa Fe
(505) 471-7007

New York

Amherst
Northtown Volkswagen
(716) 836-4600

Amityville
Legend Volkswagen
(631) 691-7700

Bayside
Bayside Volkswagen
(516) 482-3346

Binghamton
Gault Volkswagen
(607)321-6450

Bowmansville
Schmitt's Volkswagen
(716) 683-3343

Bronx
Big Apple Volkswagen
(718) 920-1400

Brooklyn
Kings Volkswagen
(718) 646-6700

Brooklyn
Open Road VW of Brooklyn
(718) 492-6400

Cicero
Burdick Volkswagen
(800) 233-2002

East Rochester
Vincent Volkswagen
(585) 586-2225

Fayetteville
Romano VW of Fayetteville
(315) 637-4668

Glenmont
Capital Cities Imported Cars
(518) 463-3141

Greenburgh
Lash VW of White Plains
(914) 931-9700

Hicksville
Platinum Volkswagen
(516) 822-4800

Volkswagen Dealers Listing

*Authorized Wholesale Mechanical Dealers shown in blue.

Huntington Station
Habberstad Volkswagen
(631) 470-8180

Ithaca
Maguire Automotive
(607) 257-1515

Kingston
Heart Volkswagen
(845) 336-6600

Latham
Martin Nemer Volkswagen
(518) 785-5581

Lynbrook
Sunrise Volkswagen
(516) 596-5970

Marcy
Paolozzi's Car World
(315) 736-8291

Middletown
Compass Volkswagen
(845) 344-4440

Mohegan Lake
Mohegan Lake Motors
(914) 528-2528

Nyack
Palisades Volkswagen
(845) 689-3536

Oneonta
Oneonta Volkswagen
(800) 351-8166

Orchard Park
Volkswagen of Orchard Park
(716) 662-5500

Pleasantville
Prestige Imports
(914) 769-5100

Queensbury
Garvey Volkswagen
(518) 793-3488

Rensselaer
Cooley Motors
(518) 283-2902

Riverhead
Riverhead Bay Volkswagen
(631) 727-5590

Rochester
Dorschel Volkswagen
(585) 334-9440

Rome
Volkswagen of Rome
(315) 337-8900

Sayville
Donaldson's
(631) 567-8100

Schenectady
Langan Motorcar
(518) 374-2225

St. James
Smithtown Volkswagen
(631) 724-6600

Staten Island
Open Road VW of Staten Island
(718) 513-7515

Wappingers Falls
Hudson Valley Volkswagen
(845) 298-2365

Watertown
F.X. Caprara Volkswagen
(315) 788-7400

NYWoodside
Koeppel Volkswagen
(718) 728-5300

North Carolina

Asheville
Deal of Asheville
(828) 232-4002

Burlington
Maxwell Volkswagen
(336) 227-2727

Cary
Leith Volkswagen
(919)297-1640

Charlotte
Carolina Volkswagen
(800) 489-2336

Charlotte
VW of South Charlotte
(704) 552-6500

Durham
Southern States VW/Durham
(888)998-0075

Fayetteville
Valley Auto World, Inc.
(910) 867-7000

Goldsboro
Frema Motors, Inc.
(919) 778-1010

Greensboro
Flow Motors of Greensboro
(336) 856-9050

Greenville
Joe Pecheles Volkswagen
(252) 756-1135

Hickory
Paramount Automotive Grp.
(828) 328-4012

Huntersville
Keffer Volkswagen
(704) 766-2129

Jacksonville
National Volkswagen
(910) 938-1417

Raleigh
Southern States Volkswagen
(919) 863-6638

Wilmington
Bob King Volkswagen
(910) 392-3889

Winston-Salem
Flow Motors
(336) 761-3698

North Dakota

Fargo
Valley Imports
(701) 277-1777

Ohio

Akron
Dave Walter, Inc.
(330) 434-8989

Amherst
Spitzer Volkswagen
(440) 988-4444

Bedford
Ganley VW of Bedford
(440) 439-3444

Canton
Kempthorn Volkswagen
(330) 580-4916

Cincinnati
Northgate Volkswagen
(513) 741-5490

Cincinnati
Northland Volkswagen
(800) 521-PART

Columbus
Byers Imports
(614) 552-5410

Columbus
Hatfield Volkswagen
(614) 465-8989

Dayton
Evans Volkswagen
(937) 890-6200

Dayton
White-Allen Euro Auto Group
(937) 291-6000

Dublin
Midwestern Auto Group
(800) 394-2571

Fairfield
Fairfield Volkswagen
(888) 932-4734

Loveland
Kings Volkswagen of Loveland
(513) 677-2710

Medina
Medina World Cars
(330) 725-4901

Mentor
Classic Volkswagen
(440) 205-6504

North Olmsted
Ganley Westside Imports
(440) 734-2000

Perrysburg
Ed Schmidt Volkswagen
(419) 874-4331

Springfield
Bill Marine Auto Center
(937) 325-7091

Steubenville
Sunset Motors
(740) 264-1696

Willoughby Hills
Fred-Vincent Volkswagen
(440) 944-8700

Wooster
Performance Volkswagen
(330) 264-1113

Youngstown
Stadium Volkswagen
(330) 726-8948

Oklahoma

Norman
Fowler Volkswagen of Norman
(405) 310-3700

Oklahoma City
Cable Volkswagen
(405) 787-0095

Tulsa
Green Country Volkswagen
(918) 712-8989

Oregon

Beaverton
Herzog-Meier Volkswagen
(503) 372-3298

Bend
Carrera Motors
(541) 382-1711

Corvallis
Jack Scoville
(541) 753-1694

Eugene
Sheppard Motors
(541) 343-8811

Gladstone
Armstrong Volkswagen
(503) 656-1215

McMinnville
Mac Volkswagen
(503) 472-4657

Medford
Lithia Volkswagen
(541) 774-7500

Portland
Rey Reece's Friday VW
(503) 255-1014

Salem
Volkswagen of Salem
(503) 581-1421

Pennsylvania

Allentown
Faulkner-Ciocca Volkswagen
(800) 554-7165

Ardmore
Piazza VW of Ardmore
(601)642-4275

Butler
Mikan Volkswagen
(724) 287-4763

Chadds Ford
Garnet Volkswagen
(610) 361-0624

Colmar
North Penn Imports
800-887-2111

Danville
Jack Metzer Volkswagen
(570) 275-2212

Devon
Fred Beans Volkswagen
(800) 803-9829

Dubois
Central Volkswagen
(814) 583-5121

Easton
Young Volkswagen
(610) 991-9140

Edgemont
Y B H Sales & Service
(610) 356-3493

Erie
New Motors
(800) 352-1052

Feasterville
Colonial Volkswagen
(215) 355-8856

Greensburg
Sendell Motors
(724) 837-9500

Harrisburg
Sutliff Volkswagen
(877) 203-5832

Hollidaysburg
Fiore Volkswagen
(814) 695-5533

Kingston
Wyoming Valley Motors
(570) 288-7411

Lancaster
Autohaus Lancaster
(717) 299-0325

Langhorne
Volkswagen Langhorne
(800) 298-4300

Lebanon
H.A. Boyd
(717) 273-9385

Leesport
Vision Volkswagen
(610) 777-6500

McMurray
Three Rivers Volkswagen
724-941-6100

Mechanicsburg
Cumberland Valley Motors
(717) 697-9448

Monroeville
Day Volkswagen
(724) 327-4950

Montoursville
Fairfield Volkswagen
(570) 368-8121

Moon Twp
Day Apollo
(412) 264-0253

New Kensington
Hillcrest Volkswagen
(724) 335-9847

Norristown
Jim Wynn Volkswagen
(610) 539-4622

Orwigsburg
J. Bertolet
(570) 366-0501

Philadelphia
Northeast Volkswagen
(215) 824-0800

Scranton
Kelly Volkswagen
(570) 347-5656

State College
Volkswagen State College
(814) 237-0368

Warrington
Holbert's Volkswagen
(215) 343-1600

Wexford
Billco Motors
(724) 940-1000

Whitehall
Gilboy Volkswagen
(610) 434-4211

York
York Volkswagen
(866) 893-2337

Puerto Rico

San Juan
Euroclass Motors
(787) 782-4087

Rhode Island

East Providence
Scott Volkswagen
(401) 434-8678

Wakefield
Speedcraft Volkswagen
(401) 792-3300

West Warwick
Fiore Volkswagen
(401) 822-4400

South Carolina

Columbia
Wray Volkswagen
(800) 424-0183

Greenville
Steve White Volkswagen
(864) 288-8300

Mount Pleasant
Low Country Volkswagen
(843) 881-8555

Volkswagen Dealers Listing

*Authorized Wholesale Mechanical Dealers shown in blue.

Myrtle Beach
East Coast Volkswagen
(843) 215-6500

North Charleston
Stokes Volkswagen
(843) 767-2525

Spartanburg
Vic Bailey Volkswagen
(864) 585-2492

Sumter
Goodwin Volkswagen
(803) 469-2595

South Dakota

Rapid City
Liberty Volkswagen
(605) 718-1000

Sioux Falls
Graham Automotive
(605) 336-3655

Tennessee

Bristol
Wallace Volkswagen
(423) 764-1145

Chattanooga
Village VW of Chattanooga
(423) 855-4981

Clarksville
Gary Mathews North
(931) 552-1111

Franklin
Hallmark VW at Cool Springs
(615) 236-3200

Johnson City
Wallace VW of Johnson City
(423) 952-0888

Kingsport
Fairway Volkswagen
(423) 578-3625

Knoxville
Harper Volkswagen
(865) 691-5569

Madison
Hallmark Volkswagen
(615) 859-3200

Memphis
Gossett Volkswagen
(901) 388-8989

Memphis
Gossett VW of Germantown
(901) 333-8989

Murfreesboro
Southeast Signature Motors
(615) 898-0700

Texas

Abilene
Sterling Volkswagen
(325) 673-4663

Arlington
Randy Hiley VW of Arlington
(817) 575-6100

Austin
Maund Automotive Group
(512) 420-2409

Brownsville
Payne Volkswagen
(956) 350-4488

Bryan
Garlyn Shelton Imports
(979) 776-7600

Corpus Christi
Volkswagen of Corpus Christi
(361) 654-8410

Dallas
Boardwalk VW Park Cities
(214) 561-8100

El Paso
Hoy-Fox Automotive Market
(915) 778-7788

Fort Worth
Autobahn Motorcars
(817) 336-0885

Garland
Rusty Wallis Volkswagen
(972) 271-6767

Georgetown
Hewlett Volkswagen
(512) 681-3510

Houston
Archer Volkswagen
(713) 272-1750

Houston
Clear Lake Volkswagen
(281) 848-5660

Houston
DeMontrond Automotive Grp
(281) 872-3909

Houston
Momentum Volkswagen
(713) 596-3380

Houston
Momentum VW Jersey Village
(281) 925-5160

Houston
West Houston Volkswagen
(281) 675-8600

Irving
Metro Volkswagen
(800) 527-7287

Killeen
Automax Volkswagen
(254) 699-2629

Lewisville
Lewisville Volkswagen
(972) 538-0550

Longview
Gorman-McCracken VW
(903) 753-8657

Lubbock
Gene Messer Volkswagen
(806) 793-8844

McKinney
McKinney Volkswagen
(800) 565-9807

Mission
Payne Mission
(956) 584-6300

Richardson
Boardwalk Volkswagen
(214) 453-5020

San Antonio
Ancira Volkswagen
(210) 681-5050

San Antonio
Rod East Volkswagen
(210) 824-1971

Temple
Garlyn Shelton Volkswagen
(254) 773-4634

Tyler
Crown Motor Company
(903) 561-3422

Wichita Falls
Herb Easley Motors
(940) 723-6631

Utah

Layton
Cutrubus Motors Volkswagen
(877) 725-1234

Orem
Ken Garff Motors
(801) 374-1751

Salt Lake City
Strong Volkswagen
(801) 433-2269

South Jordan
Volkswagen SouthTowne
(801) 676-6409

St. George
Findlay Volkswagen
(435) 986-8850

Vermont

Barre
Walker Volkswagen
(802)223-3434

Manchester Center
Hand Volkswagen
(802) 362-1754

Rutland
Kinney Motors
(802) 775-6900

South Burlington
Volkswagen South Burlington
(802) 658-1130

Virginia

Alexandria
Alexandria Volkswagen
(703)684-7007

Charlottesville
Flow Volkswagen
(434) 296-4147

Chesapeake
Greenbrier Volkswagen
(757)366-0833

Fairfax
Fairfax Imports
(703) 273-6700

Fredericksburg
Bill Britt Volkswagen
(540) 898-1600

Lynchburg
Terry Volkswagen
(434) 239-2601

Newport News
Casey Volkswagen
(757) 988-1275

Richmond
Brown's Volkswagen
(804) 379-6610

Richmond
West Broad Volkswagen
(804) 270-9000

Roanoke
First Team Volkswagen
(800) 277-0717

Springfield
Volkswagen Springfield
(703) 451-2389

Staunton
Rule
(540) 886-2357

Sterling
Lindsay Volkswagen of Dulles
(703) 880-8160

Vienna
Stohlman Volkswagen
(703) 287-4115

Virginia Beach
Checkered Flag Volkswagen
(757) 490-1111

Winchester
Miller Volkswagen
(540) 868-9916

Woodbridge
Karen Radley Volkswagen
(703) 550-0202

Washington

Auburn
Auburn Volkswagen
(800) 827-2787

Bellevue
Chaplin's Bellevue Volkswagen
(425) 641-2002

Bellingham
Roger Jobs Volkswagen
(360) 734-5230

Bremerton
Parr Volkswagen
(360) 377-3855

Burlington
KarMart Volkswagen
(360) 757-0815

Edmonds
Campbell Nelson Volkswagen
(425) 778-1131

Everett
Pignataro Volkswagen
(425) 348-3141

Kennewick
Overturf Motor Company
(509) 586-3185

Oak Harbor
Whidbey Island Auto Group
360-675-2218

Olympia
Hanson Motors
(360) 943-2120

Port Angeles
Dan Wilder Volkswagen
(360) 452-9268

Seattle
Carter Volkswagen
(206) 782-7474

Seattle
University Volkswagen
(206) 634-3322

Spokane
Appleway Volkswagen
(509) 892-2243

Tacoma
Robert Larson's Autohaus
(253) 671-6420

Vancouver
Hannah Volkswagen
(360) 314-0450

Yakima
Steve Hahn Performance VW
(509) 248-4700

West Virginia

Barboursville
Moses Volkswagen
(304) 736-5244

Clarksburg
Star Motor Company
(304) 623-7827

Parkersburg
Larry Simmons
(304) 485-5451

South Charleston
Joe Holland Volkswagen
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