

TechConnect

V7 | N1 | Winter 2015

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Das Auto.

Six-Speed Secrets



HVAC

**Certified Collision Repair
Camshafts do Double-Duty**

**Professional driver on a closed course. Do not attempt.*

VWoA Company Profile:

Wholesale Team

The Volkswagen of America After Sales Wholesale Team was formed in March 2014 and consists of automotive parts professionals with very diverse backgrounds. When the team was being formed, we were looking for people who could bring various skill sets to the table, states Scott Barone – Senior Manager of VWoA Wholesale Operations. The VWoA Wholesale Team members have extensive experience in logistics, inventory management, sales/marketing, product management, communications, finance and dealer relations. The nine member team works unilaterally and their approach behind everything they do is to share knowledge with one another. “The days of harboring the best ideas for self-serving reasons are long gone and a very myopic way of thinking,” says John Young, the VWoA Wholesale Field Operations Manager. We’re constantly discussing best practices and helping one another become more knowledgeable in all facets of the business. It is the only way to separate ourselves as a team and maintain a competitive advantage in a very tough marketplace.” The approach appears to be working. In the team’s first year, Volkswagen of America ranked Best in Class in Wholesale Mechanical and 2nd overall in Wholesale Collision⁽¹⁾ among 21 participating OEM brands.

Now the VWoA Wholesale Team wants to take its working approach to a new level. “Everyone is being

encouraged to come up with new and innovative ways to help dealers”, says Barone. As a team, we listen to our dealerships and understand their challenges both internally and externally. We do not attempt to dictate any specific business philosophy.. ever.

One area where the VWoA Wholesale Team has a distinct advantage is in its sales and marketing programs. Concurrent to when the team was formed, Volkswagen was developing an enhanced Customer Relationship Management tool for its dealership. The results have been very impressive. Today, dealers who are serious about the wholesale business are actively using CRM to help them grow the wholesale business. And these dealers are seeing significant wholesale growth when compared to non-participating dealers. The idea behind CRM is straightforward... build a stronger relationship with your wholesale customer.. be it an independent collision or repair shop.

Today, there are over 100,000 Independent automotive shops throughout the US and regardless of the vehicle make or model, vehicle owners want choices. It all revolves around service and convenience, so if a Volkswagen owner doesn’t return to the dealership for service, the next best option is to ensure he or she receives genuine original equipment parts. It is that simple. ●



Pictured from left to right: Tom Piefer, Ashley Biggs, Andrew Bash, Darrell Wright, Scott Barone, John Harrison, Alex Malyshev, Cindy Moreen and John Young.

(1) Research conducted in October 2014 - Carlisle North American Parts Manager Survey

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Your Source for Genuine Volkswagen Repair Information.



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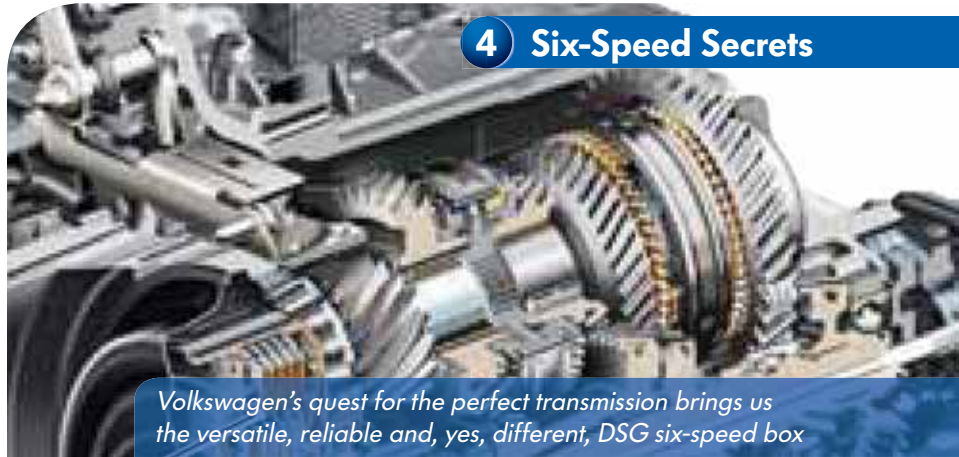
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Caution: Vehicle servicing performed by untrained persons could result in serious injury to those persons or others. Information contained in this publication is intended for use by trained, professional auto repair technicians ONLY. This information is provided to inform these technicians of conditions which may occur in some vehicles or to provide information which could assist them in proper servicing of these vehicles.

Properly trained technicians have the equipment, tools, safety instructions, and know-how to perform repairs correctly and safely. If a condition is described, DO NOT assume that a topic covered in these pages automatically applies to your vehicle or that your vehicle has that condition. For specific warnings pertaining to the servicing of specific Volkswagen systems and features, refer to: <https://www.erwin.volkswagen.de/erwin/showhome.do>.



4 Six-Speed Secrets

Volkswagen's quest for the perfect transmission brings us the versatile, reliable and, yes, different, DSG six-speed box



10 Keep 'em Comfy

Do you have a solid understanding of how these systems work? If not, your diagnosis and repair efforts will suffer.



16 VW Camshafts Do Double-Duty

VW exhaust valves have a split personality



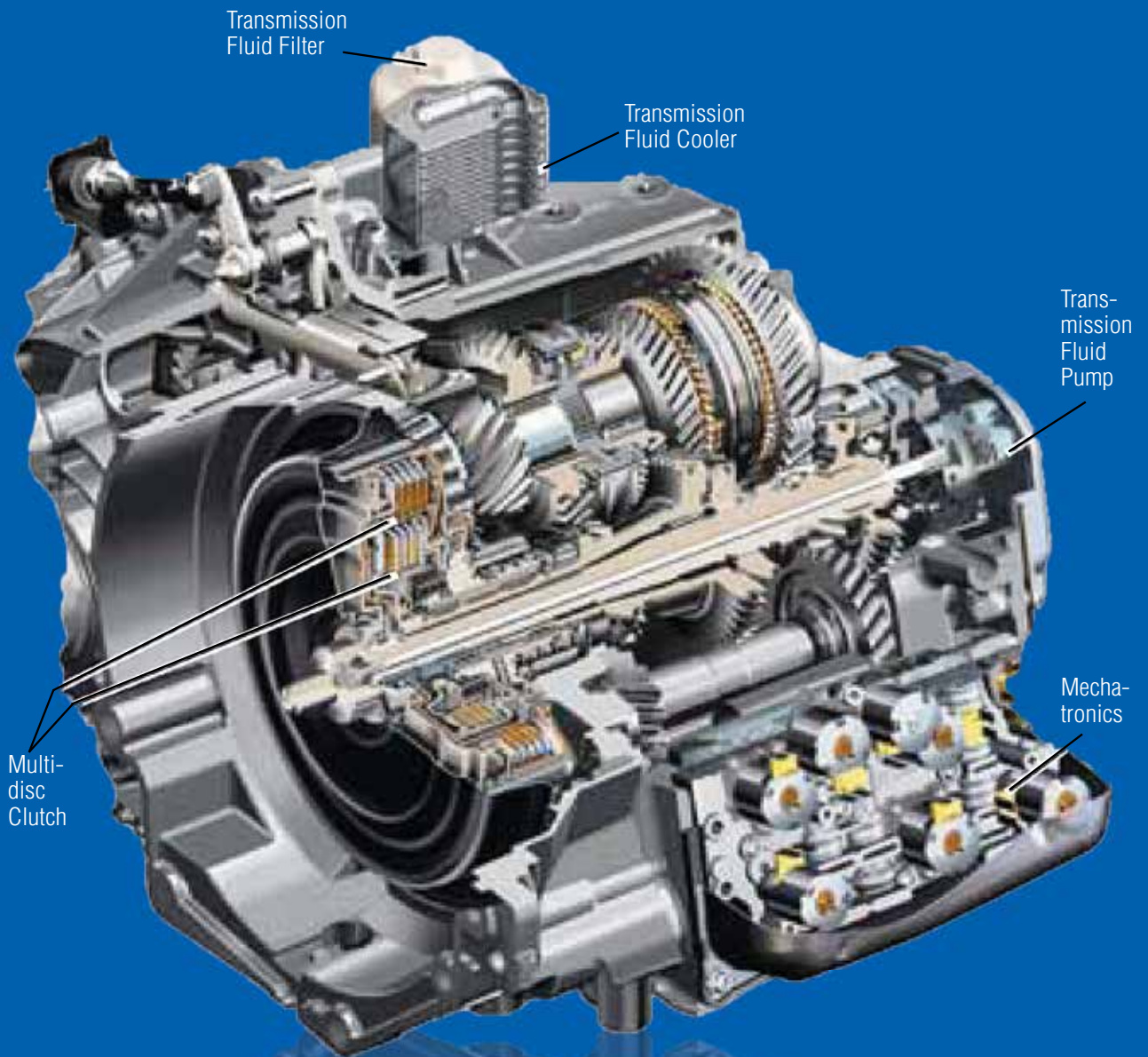
22 Volkswagen Certified Collision Repair Facility

Fixing the Car and the Process

28 Authorized Volkswagen Dealers

Six-Speed Secrets

Volkswagen's quest for the perfect transmission brings us the versatile, reliable and, yes, different, DSG six-speed box





Ever since the first automobile was built, automakers have been looking for the ideal transmission that would transmit power seamlessly from one gear to the next, provide enough ratios so that there's always one perfectly suited to any driving condition, and that will operate at optimal efficiency. A plus would be a transmission that would operate as an automatic, but also make available manual shifting for those who like to drive with élan.

The problem is, for the last hundred-plus years that cars have been taking people from where they are to where they need to be, all the rules have continued to change. Today's sophisticated electronically-controlled engines bear little resemblance to their forebears, we've gone from rear wheel drive to front wheel drive to all wheel drive, we now have emissions and fuel economy standards with which to comply, and we have motorists who today have extraordinary expectations for driveability and reliability.

So the design of today's transmissions, like those of other automotive parts and systems, are challenged by moving targets that will likely never stop to take a rest while technology catches up.

In the early 2000s, Volkswagen engineers produced a unique 6-speed transmission that could be driven in automatic or semi-automatic mode. What distinguished this transmission from other designs was that it was actually two manual transmissions operating in concert, without the need for a manually-operated clutch, making it a Direct Shift Gearbox (DSG). It was quite an ingenious design, and offered a number of features not found in other transmissions:

- With six speeds, there would always be a gear ratio available for nearly every possible driving condition and availability of engine torque and speed.
- It could be shifted manually without the need for a driver-operated clutch.
- Being based on two complementary manual transmissions, it had fewer and stronger components, and fewer and simpler control systems.
- It was still electronically controlled, for precision and interface with other vehicle dynamics and the demands of various driving conditions.
- The strength and durability of helically-cut drive gears help make for smooth, quiet operation even under heavy torque demands.

How do three plus three equal six?

Actually, three plus four equals seven, if you count reverse. The essence of the DSG transmission is two manual transmissions -- one for first, third, fifth, and reverse, and the other for second, fourth, and sixth gear. Each of the two transmissions has its own wet clutch assembly, and all transmission functions are controlled by a Mechatronics electronic control unit, which, interestingly, is internal to the transmission and is constantly immersed in transmission fluid.

Being based on two manual transmission units, the driven gears are always meshed with the equivalent of a "cluster" gear, so they're always waiting for synchronizer action to mechanically connect them to their respective "mainshaft," and ready for the clutch on that mainshaft to engage and transmit power on to the drive wheels.

The ingenuity of the DSG is that each of the two transmissions is always engaged in one of its gears, as determined by the Mechatronics unit. So if power is transmitted through first gear in one gearbox, the other gearbox already has second gear engaged. So all that's needed is instructions from the Mechatronics unit to disengage the clutch at the first transmission while it smoothly engages the clutch of the second transmission.. And, just like that, the car has shifted from first into second gear.

Now, as you would expect, once the vehicle is being propelled in second gear, the Mechatronics unit directs the first transmission to disengage first gear, which is no longer needed, and engage third gear so it is ready for the Mechatronics unit to pass the torch on up to third gear. And so the process continues up through all six forward speeds. The two clutches are mounted concentrically on a mainshaft to further promote smooth upshifts and downshifts.

In the meantime, the Mechatronics unit constantly monitors driving conditions, so that the transmission not currently engaged shifts either up or down depending on anticipated power needs and driving conditions.

With engine speed necessarily dropping when upshifting, throttle modulation is not needed, especially since the dual-clutch setup can change gears very quickly and smoothly. However, when the transmission is downshifting, the ECU is smart enough to know to "blip" the throttle to match revs to the new, lower gear. It's all quite clever.

A particularly interesting feature of the DSG transmission is the synchronization of the various gears. First, second, and third gears are actually equipped with what Volkswagen refers to as triple synchronization. We're all familiar with how a synchro ring works in a conventional manual transmission. A soft, tapered conical ring is moved into mesh with a mating ring and, as the tapers join up, the speed of the two devices match speeds, providing the synchronization needed to avoid clashing of gears. This triple synchronization provides much larger heat transfer surfaces, necessary because the rotational speed differences are higher in these lower gears. Fourth, fifth, and sixth gears all use the more conventional single synchronizer.

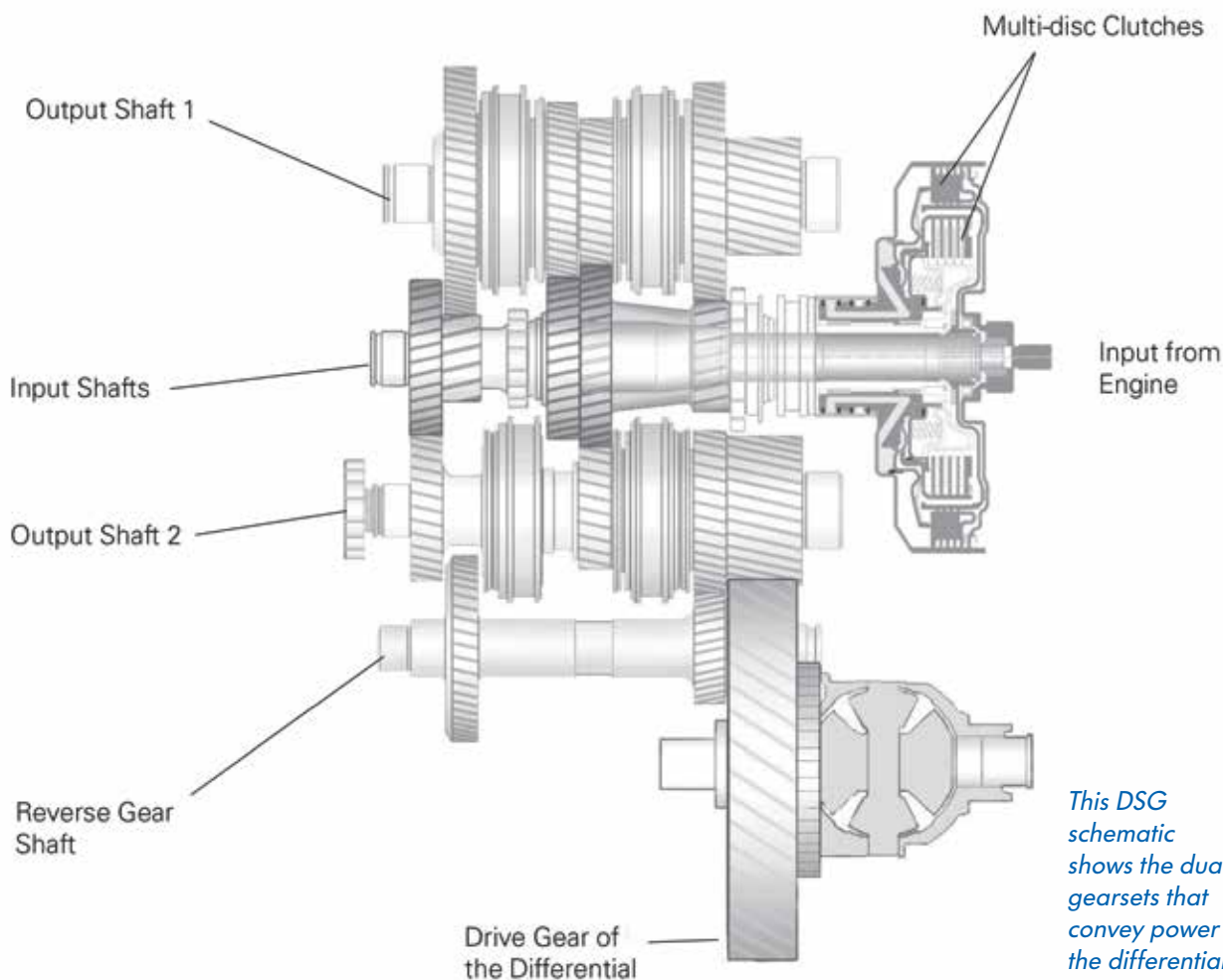
With VW triple synchronization, there are three, not just one, synchro rings, so that the first matches speed with the second one, the second matches speed with the third, and the third matches with the tapered cone on the gear itself.

This DSG design also includes two other driver-friendly provisions -- a "hill holder" function that holds the stopped vehicle on an uphill road even if brake pedal pressure is relaxed, and also a "creep" function that allows the car to ease forward on level ground if the brake pedal is not depressed.

How smart is the brain?

The Mechatronics unit is quite sophisticated, incorporating no fewer than twelve separate sensors, input from which the ECU uses to operate eight hydraulic gear actuators, six pressure modulation valves, five control valves, and the pressures and cooling of the two wet clutch assemblies. It is also a "smart" module, with the capability of learning the positions of the clutches and of the actuators for each gear, and the main transmission fluid pressure. It is also adaptive and can "learn" operators' driving habits and adjust shift characteristics accordingly.

Furthermore, VW engineers did a surprisingly thorough job of anticipating possible component and



This DSG schematic shows the dual gearsets that convey power to the differential.

system failure, and, as a result, integrated a host of fail-safe modes and actions into the Mechatronics unit. What this means is that drivers, and sometimes even technicians, may not be aware of a malfunction within the DSG transmission, since the Mechatronics unit may already be compensating for a sensor or other component that's not doing its job.

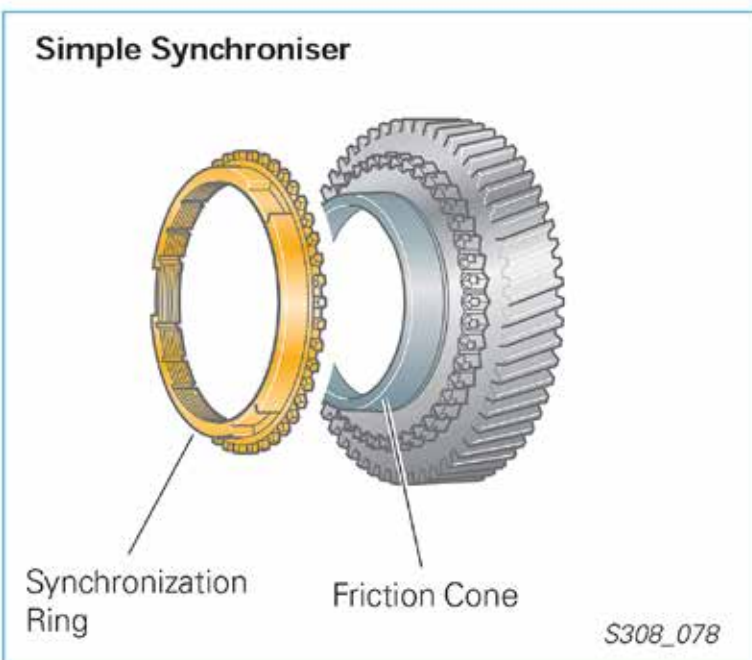
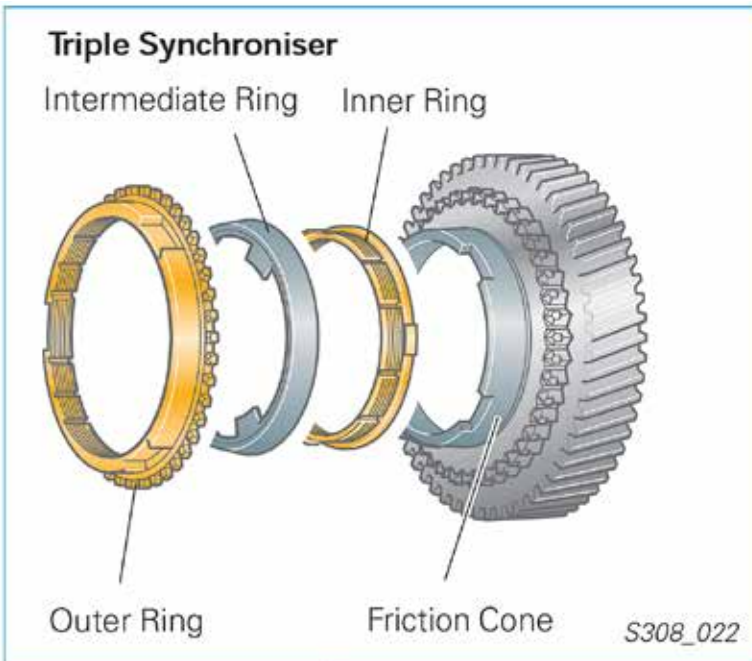
The technician's job is made even easier by the fact that most of the controlling functions of this transmission are found within the Mechatronics unit, which is largely self-diagnosing. Other malfunctions also tend to be intuitive in their diagnosis. Mostly, to the benefit of both the motorist and the technician, these transmissions tend to have few failures.

Zero in on the problem

Because most of the sensors, solenoids, control valves, and actuators are integrated into the Mechatronics unit, a Check Engine light with an accompanying OBD II fault code will alert the driver and technician to the specific problem area. More serious conditions may be brought to the driver's attention by a repeated flashing of the PRNDS indicators. Other indications of a problem with this transmission can include an anomaly found during a test drive, observing that the transmission goes into limp-in mode, shuddering when accelerating from a stop, or banging when the transmission shifts into first gear.

An astute driver may also notice the failure of the transmission to shift up or down into the next numerical gear, or possibly operate only in a fail-safe mode of, perhaps, just second or third gear (out of the six he or she is accustomed to...). Similarly, slippage during shifting would alert an observant driver to a clutch problem, and would likely be accompanied by a Check Engine light and appropriate fault code.

If the Check Engine light illuminates, follow the appropriate diagnostic tree. Most of the time you'll find that the Mechatronics unit is the source of trouble, since it performs such a vast and diverse array of functions. The units are not serviceable, and must be replaced if faulty. Note that these units are vehicle-specific, so if you determine that you have to replace a faulty one, you'll need to provide the VIN to the parts department of your local VW dealership and they will need to order a new unit specific to that vehicle.



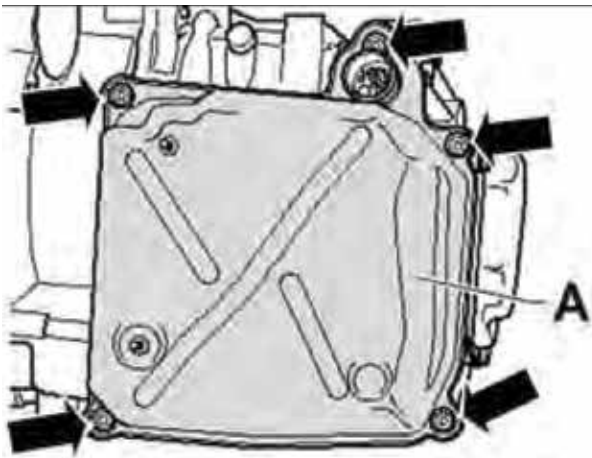
The triple synchronizer is used on the first, second, and third gears; the single synchronizer is used on fourth, fifth, and sixth gears.

Less common are clutch failures, which require removal of the transmission from the vehicle and a host of special tools and procedures. Any other failure calls for replacement of the entire transmission.

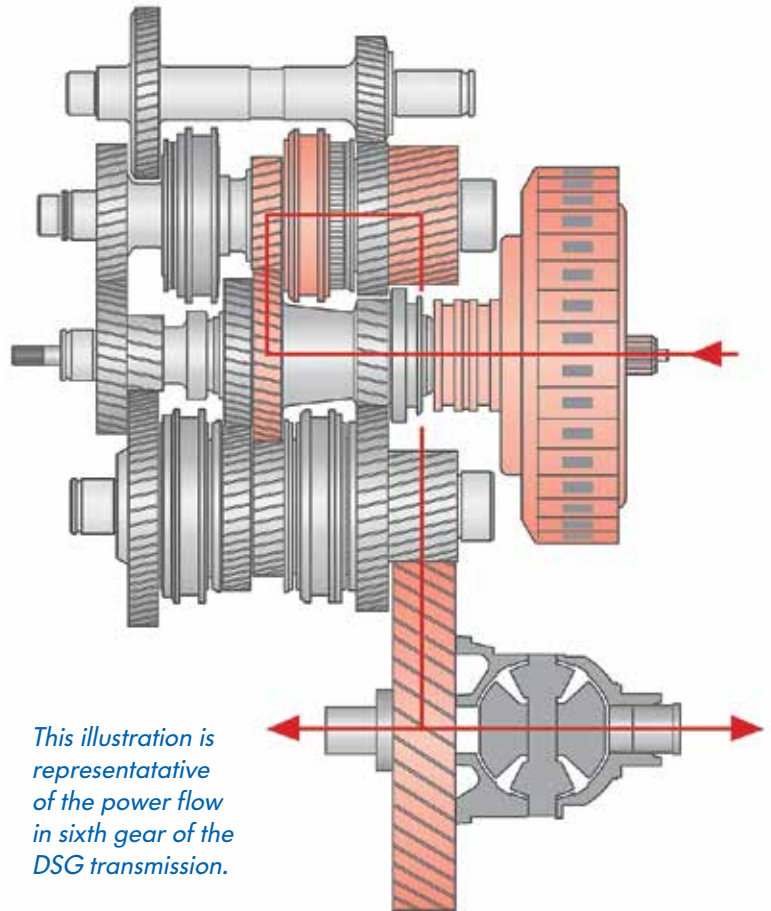
But if it is the Mechatronics unit...

The Mechatronics unit is located with the valve body within the transmission housing, and is accessible after removal of the side cover; there is no conventional sump on the bottom to remove. Replacement of the Mechatronics unit is not a simple procedure, and Volkswagen has produced a detailed video and instructional program covering the proper tools and procedures needed for this job, and the company considers it essential that technicians study both the video and the training material before undertaking this repair.

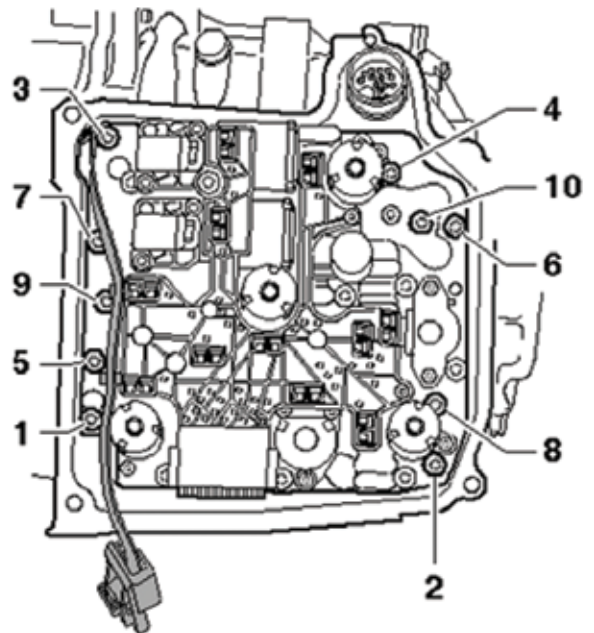
While most of the electro-hydraulic actuators, solenoids, and valves are integral with the Mechatronics and are, therefore, non-serviceable, there are a few sensors and other separate components that are located remotely and can be serviced separately. Your diagnostic software program should identify their role and location, and you can also find support by asking the folks at your local Volkswagen parts department, who will be familiar with the system you're working on. ●



The Mechatronics unit is mounted behind a cover plate and is immersed in transmission fluid. This fluid must be drained before accessing the Mechatronics unit.



This illustration is representative of the power flow in sixth gear of the DSG transmission.



The Mechatronics unit is mounted with ten bolts which must be removed and installed in sequence. These are single-use bolts and must be replaced at every service.



Volkswagen recommends Castrol

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Keep 'em Comfy

Do you have a solid understanding of how these systems work? If not, your diagnosis and repair efforts will suffer.





Early motor vehicles didn't offer much in the way of climate control. A woefully inadequate amount of heat was typically ducted from over the exhaust manifold, and air conditioning didn't even appear until the late 1930s -- that is, unless you count placing a bucket of ice on the floor in front of a vent.

We've come a long, long way. The need for the defrost function so you can see where you're going in icy weather was the first impetus for making decent heating mandatory, then common humanity impelled the car makers to do whatever was necessary to relieve the suffering of motoring mankind.

Have we become spoiled? Perhaps so. On the other hand, is there really any good reason why we should have to freeze or broil in the cabin of a car? Not when such great HVAC systems are standard equipment in modern Volkswagen vehicles. Besides, studies have shown that people drive more safely when car interiors are kept within a comfortable range of temperatures.

We're not going to get into the theories of thermodynamics and refrigeration beyond mentioning that the Second Law of Thermodynamics states that heat always travels from a warmer object to a colder object. What we intend to share with you here are some of the subtleties of controlling and maintaining heating, ventilation, and air conditioning in common Volkswagen models of years past, which is what you are probably working on now.

Hot box

All modern Volkswagen models have what's known as a "hot box." In other words, coolant is always flowing through the heater core in the air distribution housing. Combined with the action of the blend doors, this makes for much more precise control of cabin temperature than the old-fashioned idea of restricting flow through this heat exchanger, and it's also less prone to problems such as stuck or leaky coolant-control valves.

All the air that reaches the vents has passed through the evaporator whether it's for heating or A/C.

Clean air

Over a decade ago, VW adopted a big advance in clean cabin air: a dust, pollen, and odor filter. All fresh

outside air entering the vehicle for both heating and air conditioning passes through this filter. It is constructed with an activated charcoal layer between the dust and pollen filter elements. The activated charcoal removes odors and some pollutants such as ozone, which is converted to oxygen. The filter should be replaced according to the maintenance schedule, or more often if the vehicle is driven in dusty conditions.

While you'll probably be able to endure sweltering in a car without A/C, you might not survive frigid weather unless the heating function is working. So, keeping the interior above that at which frostbite occurs is the HVAC engineer's top priority.

Although the low heat-rejection of hyper-efficient Volkswagen diesels and FSI® gasoline engines make harvesting enough excess Btus to keep the cabin warm more difficult than it was in the fuel-wasteful past, Volkswagen has come up with ingenious designs that help maximize this process, providing more than enough heat for even Arctic conditions -- when they're operating properly.

Complaints of inadequate heat are typically caused by:

- Low coolant level
- A faulty thermostat -- or perhaps it was removed altogether
- A heater core plugged with deposits or debris (trying to remove these either with air pressure, or by twisting a flexible cable through the coils is usually not successful).
- An inoperative blower, either from electrical problems, or because something has jammed the fan. Acorns? A mouse nest?
- Blocked air flow from a clogged cabin filter, or, again, a rodent's nest.
- A blend door that doesn't move to the proper position for whatever reason

Check out these basics before you embark on any sophisticated electronics troubleshooting.

Manual? Well...

Most Volkswagen models sold over the years have had manual HVAC systems. Despite what the name implies, modern manual HVAC systems don't rely just on levers, cables, and vacuum switches. There's plenty of wiring, too. They're called "manual" because

Left: The VW Type 1 first arrived in the U.S. in 1949 -- 65 years ago! Air-cooled Beetles gave you heat off the exhaust manifolds almost instantly, just not much of it. A/C? In those days, it was just a pipe dream.

cabin temperature isn't computer-controlled. The humans aboard simply twist a knob to request a level of heating or cooling, and the system puts out what it can to achieve it. Some electrical inputs are used to help protect the compressor, however. There are ambient temperature, refrigerant pressure, and coolant temperature sensors to make sure conditions are right for engaging the electro-magnetic clutch (the clutchless variable-displacement compressors found on some late models are another story altogether, which we'll cover in a future issue of **TechConnect**). Starting with the 2000 model year, a cooling fan control unit monitors all these sensor inputs and manages the compressor clutch circuit as well as the cooling fans.

With a manual system, all of these inputs need to be working properly to activate the compressor. If any input were to fail, the compressor clutch circuit would open. Without a control unit with self-diagnostic capability, this means each input needs to be checked using pin voltages. Whether you want to check the voltage signals at the cooling fan control unit, or each individual sensor is up to you. The unit is usually mounted on the driver's side front frame rail. On a New Beetle, that would be under the battery tray, not all that easy to get to. Some cooling fan control units

have strip-type fuses secured to the top, some don't, depending on the application.

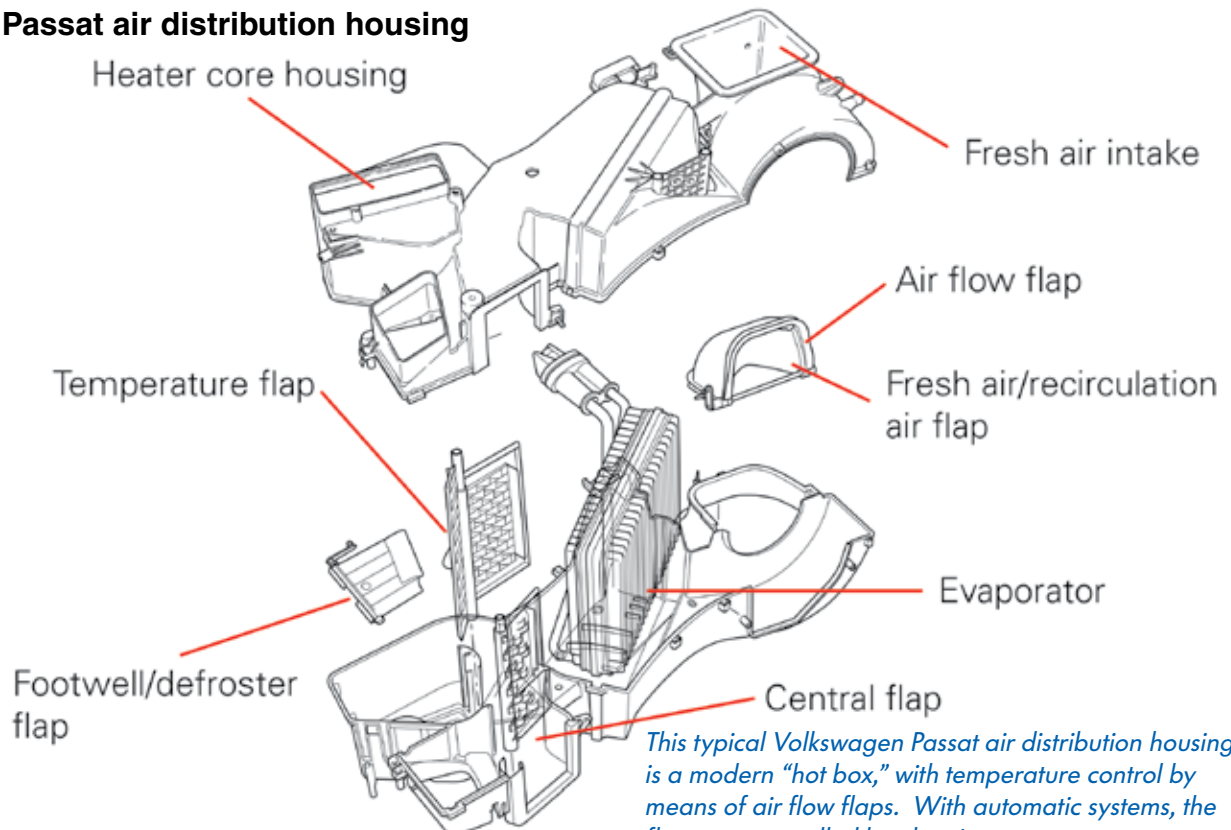
Input verification

Consider a 10-year-old Jetta VR6 with manual A/C. Its coolant fan control unit has two connectors, one four-pin and another 14-pin. On the four-pin connector, you will have the relay's power supplies, a



The traditional three dials of the Volkswagen manual HVAC system couldn't be simpler to understand and operate. This switch unit provides voltage to Pin #8 on the cooling fan control unit indicating that A/C has been requested.

Passat air distribution housing



This typical Volkswagen Passat air distribution housing is a modern "hot box," with temperature control by means of air flow flaps. With automatic systems, the flaps are controlled by electric motors.

6.0 mm solid red in Pin #1, and a 2.5 mm red/white tracer in Pin #3. They should have battery voltage at all times. In Pin #2 (2.5 mm red/white tracer) is the power supply out of the relay for low-speed fan operation. The final 6.0 mm red/white tracer is the power supply output for the high-speed fan.

The 14-pin connector is the source of activation for the internal relays, not only for the cooling fan, but also for the A/C compressor clutch. Pin #6 is a brown ground wire, and constant battery voltage comes in on pin #4, red/green tracer. Power from the ignition switch comes in on in pin #9, usually black with a blue tracer.

In order for the compressor to turn on, you need to see some inputs. The first check you should perform is on pin #8, black/red tracer. When the A/C button is pressed and the blower is commanded on, you should see battery voltage. Next, look at pin #2, a white wire. This is an unusual signal in that it is a five-volt square wave created by the refrigerant pressure sensor. The duty cycle of the signal will change with refrigerant charge. This is here to indicate if the charge is too low or too high to turn the compressor on and off, and perhaps damage it. Another signal that may inhibit compressor activation is that of the ambient temperature switch. Test for voltage between pins #5 (black/red) and #14 (green/black). If the signal indicates the air temperature is too low, it will not allow the compressor to run. Check these inputs to the cooling fan control unit whenever the compressor clutch won't engage.



Low heat? Check coolant level first -- and don't forget to bleed out any trapped air.

Whether with the manual or the automatic system we're just getting to, one common source of trouble is water infiltration. It gets into connections and causes corrosion that will introduce resistance into the circuit, or interrupt it completely. There are lots of ways this can happen. For example, a sunroof or cowl drain can plug up allowing H₂O to soak the interior, and there are often branched connections under the carpet that will corrode away if soaked. Or, a module or one of its connectors can fail in the same way. It makes sense to check for this before you start spending time doing electronic testing.

Full auto and the scan tool

Climatronic® Automatic climate control system adds automation in that after setting the temperature to a number of degrees in the cabin, an electronic unit monitors both outside and cabin temperature conditions and uses a programmed plan for how best to achieve and maintain the chosen setting. These settings vary from full defrost heat to MAX A/C. Once a temperature is set, the control unit will automatically manipulate mode doors, temperature blend doors and the recirculation door. There are manual overrides the passengers can select to control positions of the mode doors, cabin air recirculation, and A/C compressor operation. Since these electronics are overseeing system operation, Volkswagen has implemented the same self-diagnostic features found in conjunction with other control units.

You may not realize what your current scan tool is capable of. You may not even realize how much useful information you have at your fingertips. By improving your skills with this most helpful piece of equipment, you will reduce your diagnostic time and maybe get ahead of the "cost-effective diagnosis" game. Volkswagen automatic climate control systems are endowed with the same extensive self-diagnostic features as are found in powertrain control systems. While the scan tool-based diagnostic features in auto-HVAC systems are extensive, the interface is proprietary, so without knowing what you're looking for it will be difficult to interpret the data being displayed. So how does this work?

For many years, VAG® has been the factory proprietary scan tool for Volkswagen vehicles. Even if you purchase the European bundle for your aftermarket scan tool, you should still be able to display this "factory" software. The software in the scan tool allows you to communicate with all of the various control units in the vehicle. Each control unit is programmed to use the same software architecture, so what we're about to describe will work also work on ABS and SRS.

You can enter the self-diagnostic feature with your scan tool by simply picking the address word you need. So, what's an address word? With the factory scan tool, a series of numbers is used to identify the various systems you can enter. These numbers are called "address words" in your technical literature.

Where do you want to go?

Each system has its own address word. On the Volkswagen factory tester, you need to know what address word represents each system. Aftermarket diagnostic tools give the address word as well as a description of the system. In the case of automatic climate control, the address word is 08 (Auto-HVAC). Once you've selected the system, you will be asked to choose which function you'd like to perform:

- Function 01 identifies the control unit.
- Function 02 is for pulling codes.
- Function 03 is for actuation mode.
- Function 04 provides 'basic settings.'
- Function 05 clears codes.
- Function 06 ends communication with the control unit.
- Function 07 allows you to code the control unit to the particular car it is in.
- Function 08 is for reading data.

There are a few other functions to choose from, but we're going to focus on the most important ones.

Starting with function 01, you will see that this merely identifies the control unit in the vehicle as well as its version coding. This information is useful if you think the coding may have been changed in error, or that a used control unit was installed and may not match the requirements of the original one. Providing the control unit is the proper one, you can correct coding if necessary.

Function 02 is pretty self-explanatory. Auto-HVAC units are capable of self-diagnosis, and can identify faults in one or more components. These components are either sensor inputs or actuator outputs. In the case of actuator outputs, you don't always have to access the component and start your testing there. The other option is scan tool activation.

Function 03 is the mode where you can take advantage of the capabilities of the scan tool and request that the HVAC

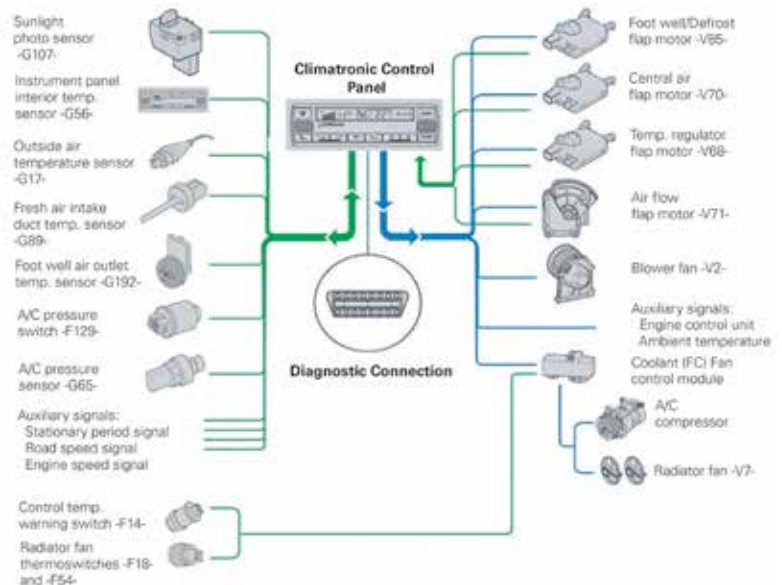
control unit activate various outputs. You can listen for the activation, and/or perform electrical testing on the component being activated. This allows you to verify that the control unit's driver is capable of turning on any component in which you may suspect a fault.

Function 04 is referred to as "Basic Settings." In general, this provides a "reset" or 're-sync' of computer-controlled features. The automatic climate control system needs to know the positions of the various temperature and mode doors in order to manipulate them if a change is requested by the occupant or detected by a temperature sensor. Basic Settings runs the control unit through the re-learn process, but more on this later.

Function 05 simply clears codes, and once you're done communicating with the HVAC control unit, you should shut down this communication by selecting Function 06. This helps prevent corruption of software



Don't overlook other cooling system bleed points.



Climatronic - typical sensors (inputs) and actuators (outputs)

As this schematic shows, automatic systems rely on numerous inputs for the information needed to decide how to command outputs.

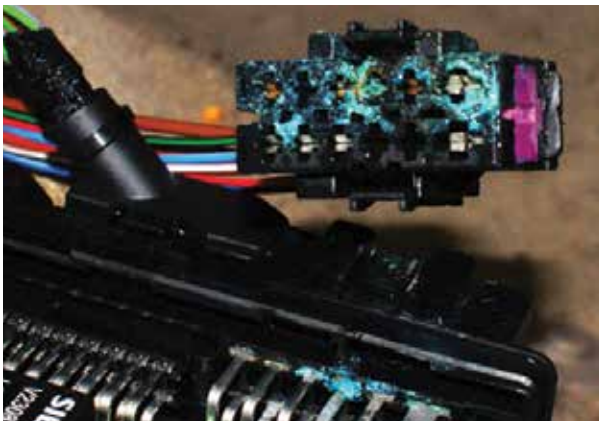
in the unit. Function 07 allows you to change the version coding. Version coding is a way for you to “tailor” the control unit to the vehicle it’s in. Vehicles come with more than one option. Each control unit must be made aware of these options in order to perform properly. This comes in handy when installing



Something as basic as this plugged cowl drain can lead to...



...serious water infiltration.



No sense doing high-tech diagnostics until catastrophic corrosion like this is corrected.

used parts. Although the replacement control unit may have the same part number, the coding must be changed to accommodate the requirements of the vehicle being repaired.

Finally, Function 08 (sometimes referred to as “data blocks,” or “measuring blocks”) allows you to look at data, such as a temperature sensor reading, or actuator position. The tricky part is that these data blocks are also identified with numbers and are displayed in blocks of four. You must look up in a table what the data blocks indicate for each display group. This information can often be found in your information system, or by purchasing books from aftermarket scan tool manufacturers.

Reset

Once you have pulled codes, diagnosed a problem, and done a repair, you may need to reset the climate control system, especially if a mode door motor was replaced. This can be achieved through the “Basic Settings” feature. You will be prompted to enter a three-digit code. Leave the code “000” in the display and enter this mode. The positions of the doors are recorded, and they will then cycle to their respective end stops. Now, the control unit knows what the maximum and minimum positions are for each mode/blend door. When it needs to make a temperature adjustment as a result of changing conditions, it can make the correct change. Without knowing the current position of the doors, it will make the wrong adjustment and output the wrong temperature.

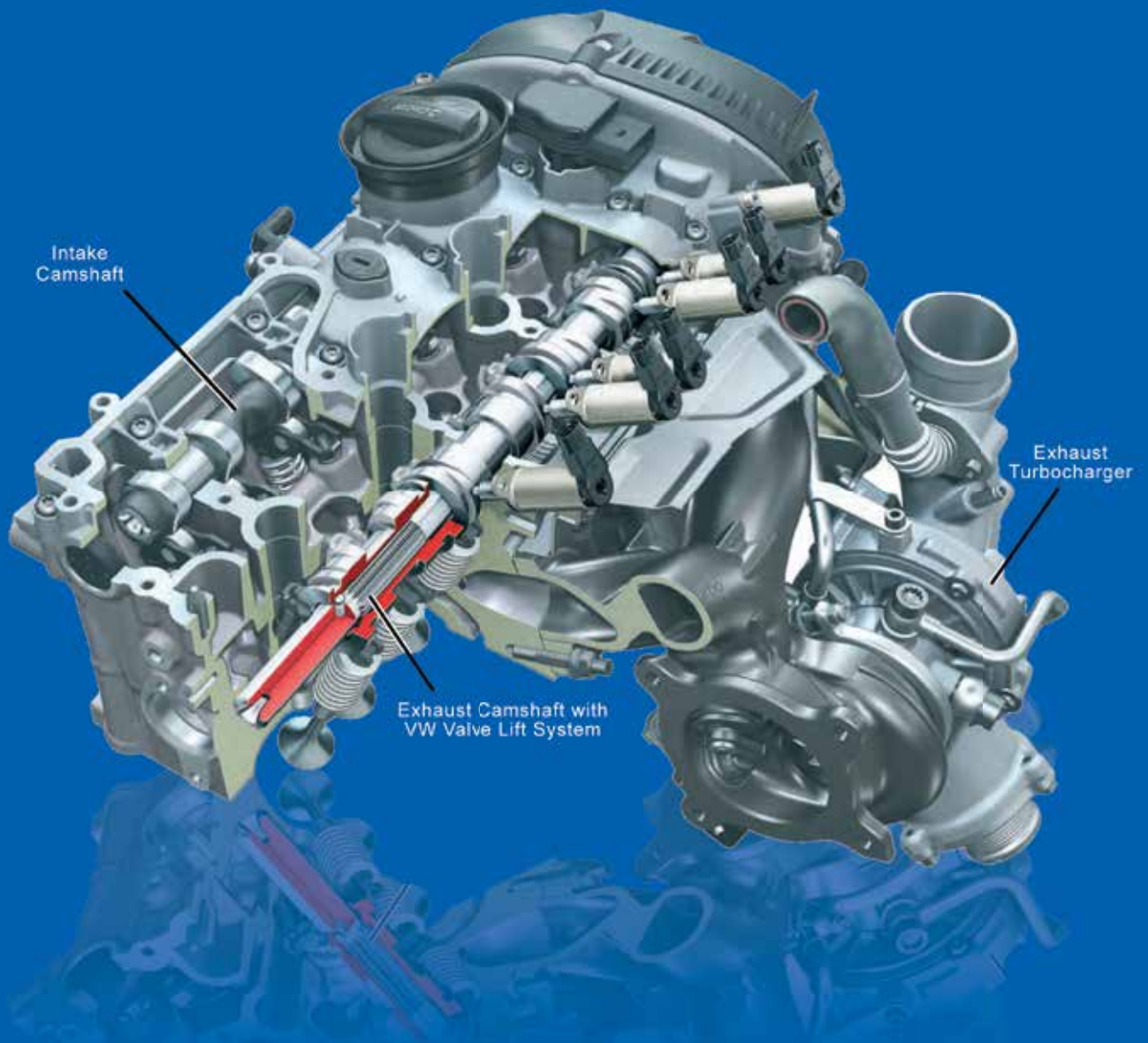
We hope that knowing the above information about typical Volkswagen HVAC systems will help you keep your customers happy with their cars -- and with your work. ●



There are many “address words” for all of the possible self-diagnostic systems on the vehicle. Select address word 08 – HVAC and you can talk to an automatic climate control system (not a manual system).

VW Camshafts Do Double-Duty

+ *VW exhaust valves have a split personality*





In the mid-2000s, Volkswagen introduced a 2.0L version of its 1.8L SOHC EA 888 engine family. This new turbocharged fuel-injected gasoline engine incorporated many of the features that had proven successful and reliable in its previous iteration, with a dual overhead cam/4-valve design, and was identified as CCTA/CBFA. Subsequent engineering led to innovative new technology for exhaust valve actuation that actually provided an exhaust camshaft with dual lobes for each valve and a sophisticated switching mechanism to alternate valve operation between two modes. This new configuration became known as the CBEA family of engines.

The dual-function exhaust valve activation allows for differing engine performance characteristics depending on demands and operating parameters, such as throttle position and other inputs as determined by various sensors and the vehicle's Motronic Electronic Control Unit (ECU). At low engine speeds, when demand for power is modest, a narrow profile cam lobe contour manages exhaust valve timing. In particular, it provides for very late valve opening, such that the exhaust pulse cannot back-flow into the cylinder during the valve overlap phase of the combustion cycle.

At the same time, under light loads, this dual-valve technology allows the intake cam to be designed in such a way that the intake valves open sooner than they would otherwise. This provides two benefits: Advanced valve timing tends to move the engine's torque curve downward, enhancing low-speed driveability and acceleration. At the same time, the earlier ingestion of the intake charge, combined with the delayed exhaust valve opening, generates a more positive charge in the cylinder, reducing the volume of spent exhaust gases remaining in the combustion chamber and retaining more of the intake charge in the cylinder at lower engine speeds.

What are the benefits?

Specific benefits of this technology include improved throttle response and higher torque at low rpm, making the torque curve steeper, and reducing turbo lag at lower engine speeds.

Conversely, at higher engine speeds, the engine switches to an alternate exhaust camshaft lobe profile that allows for more efficient combustion and enhanced fuel economy, with correspondingly lower exhaust emissions.

The dual operation of the exhaust camshaft function is an ingenious design, using separate exhaust cam "elements," one for each cylinder (remember, that as a DOHC engine, there is a separate intake cam that is unaffected by the dual exhaust cam lobe function). Each of these four exhaust cam elements is mounted on a common splined exhaust camshaft. Each of the four exhaust cam elements contains two lobes for each of two exhaust valves, such that the four exhaust cam elements contain a total of sixteen lobes, sufficient to provide dual function to each of the eight exhaust valves.

In operation, when various conditions are met, the selection of a particular exhaust cam lobe is performed by electro-mechanical solenoids that move the exhaust cam elements side-to-side, depending on the mode selected. There are two solenoids for each of the four cam elements -- one solenoid selects the large cam lobe, and the other solenoid selects the small cam lobe. A spring-loaded metal detent pin helps hold the element in the appropriate position.

Since it is the camshaft elements that move side-to-side courtesy of the solenoids, the rocker arms with their roller followers remain in a fixed position. A helical groove in the elements helps allow for a smooth transition from one lobe to its mate.

In operation, when the engine is first started, the Motronic engine management system directs the solenoids to select the larger exhaust lobes for easier startup. Immediately after the engine starts, the system changes over to the smaller lobes. Under most driving conditions, the system will retain the use of the smaller lobes up to about 3,100 rpm. Upon shut-down, the system reverts back to the larger cam lobes in preparation for the next start-up.

Service considerations

In the nearly ten years this system has been in service, it has proved to be both durable and reliable. Yet there are some items that technicians need to be aware of. The solenoids that activate the elements can, upon occasion, fail. When they do, a Check Engine light will help alert the driver to a problem, and a Diagnostic Trouble Code (DTC) will advise the technician as to which solenoid requires attention. Once the plastic engine cover is removed, the solenoids are readily visible, and are easily replaced after removal of a single Torx® fastener and electrical connector.

Similarly, the vehicle is equipped with camshaft rotation sensors, which have also been known

to develop trouble. Again, a Check Engine light and DTC will direct the servicing technician to the appropriate sensor. Less likely is a problem in the cam phaser system, but this too will be identified with the appropriate DTC.

Maintenance is especially critical

Because of the precision of this dual-lobe system, and the speed with which it must respond in order to help optimize engine performance and emissions control, it is especially critical that maintenance be performed at least as often as recommended. Due to the tight tolerances of the various components in this system, you can make a strong case for owners to schedule oil changes and other routine maintenance at the intervals spelled out in owners' manuals or electronic service reminders. Be certain to use engine oil precisely as specified for this engine family, available, of course, from your local VW parts department.

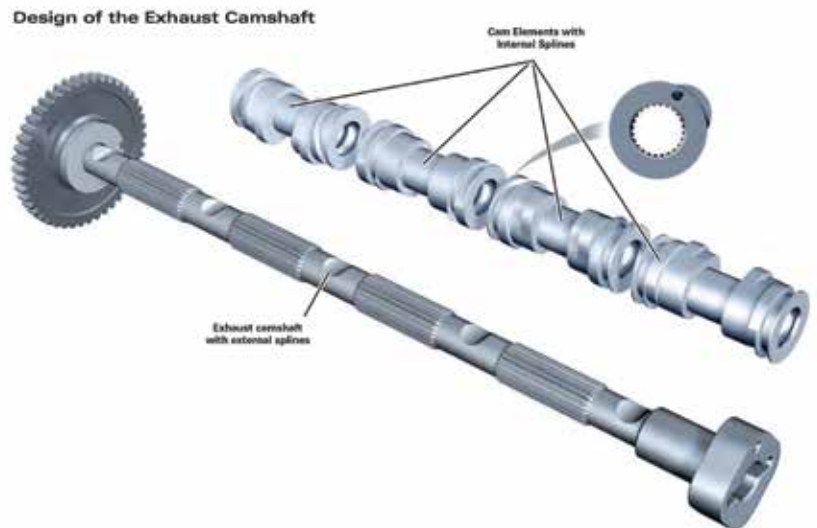
Any sludge or carbon build-up in these engines can adversely affect the performance of this sophisticated dual-valve function. This debris can cause binding or galling of the splines on the exhaust camshafts and elements, they can interfere with the proper operation of the detent balls and springs, and, of course, they can cause wear on the camshaft lobes and followers. Wear or damage on the lobes of the camshaft elements will be evidenced by an engine misfire DTC, which will direct you to the errant element and lobe.

What about the cylinder head?

With proper maintenance, cylinder head service is not required on this engine family any more than on other modern-day

engines. The cylinder head gasket is a robust MLS (Multi-Layer Steel) design, and holds up well. However, with these engines, as with all engines with aluminum cylinder heads, overheating can quickly cause a cylinder head to warp and the head gasket to fail.

If removal of the cylinder head is called for, you must exercise various cautions -- some typical of



cylinder heads from other engine families, and some specific to this engine design. For example, you should perform appropriate diagnosis before beginning any disassembly. Most likely a cylinder leak-down test coupled with DTCs that are displayed will point you to the particular problem area.

You'll want to set the engine at TDC before beginning disassembly, and be sure to take special note of markings on timing gears/sprockets, including corresponding markings on the cylinder

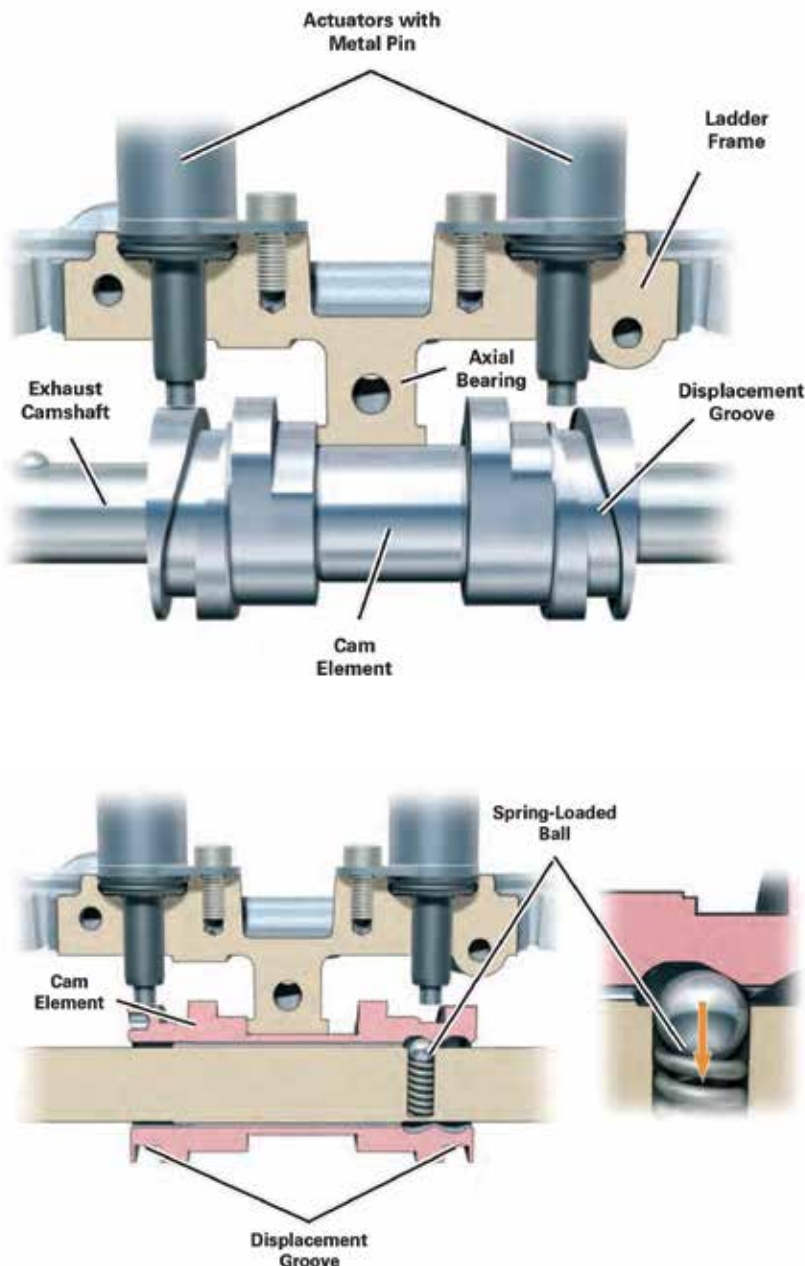
heads, and also markings for direction of rotation, since these steps will help you greatly during reassembly. Like most sophisticated engine designs, this engine family is an interference design, so you'll want to be certain not to rotate the crankshaft if the cylinder head is on and the timing chain is not in place.

Special cautions

You'll probably not be surprised to learn that the cylinder head bolts on these engines are of the Torque-To-Yield (TTY) type, which means they can only be used once and then must be discarded and replaced with new. These head bolts are not included in VW head gasket sets, and must be purchased separately.

You may be surprised to know, however, that many of the other fasteners on these engines are also TTY bolts, and cannot be re-used. Such bolts are used in various places around the engine, and also for mounting of the turbocharger. As such, the parts professional at your local Volkswagen parts department can be your best friend here, and can help identify those fasteners that must be replaced every time.

Another note of caution: Any cylinder head service will likely call for disconnecting the fuel rail from the fuel injectors. Any time the fuel system is open there is the potential for debris to enter the system. Since modern fuel injection systems work within extraordinarily close tolerances, the introduction of any debris into the system holds the potential for compromised performance and/or component damage. So, be especially careful to plug any openings in the fuel system when performing cylinder head or related services.

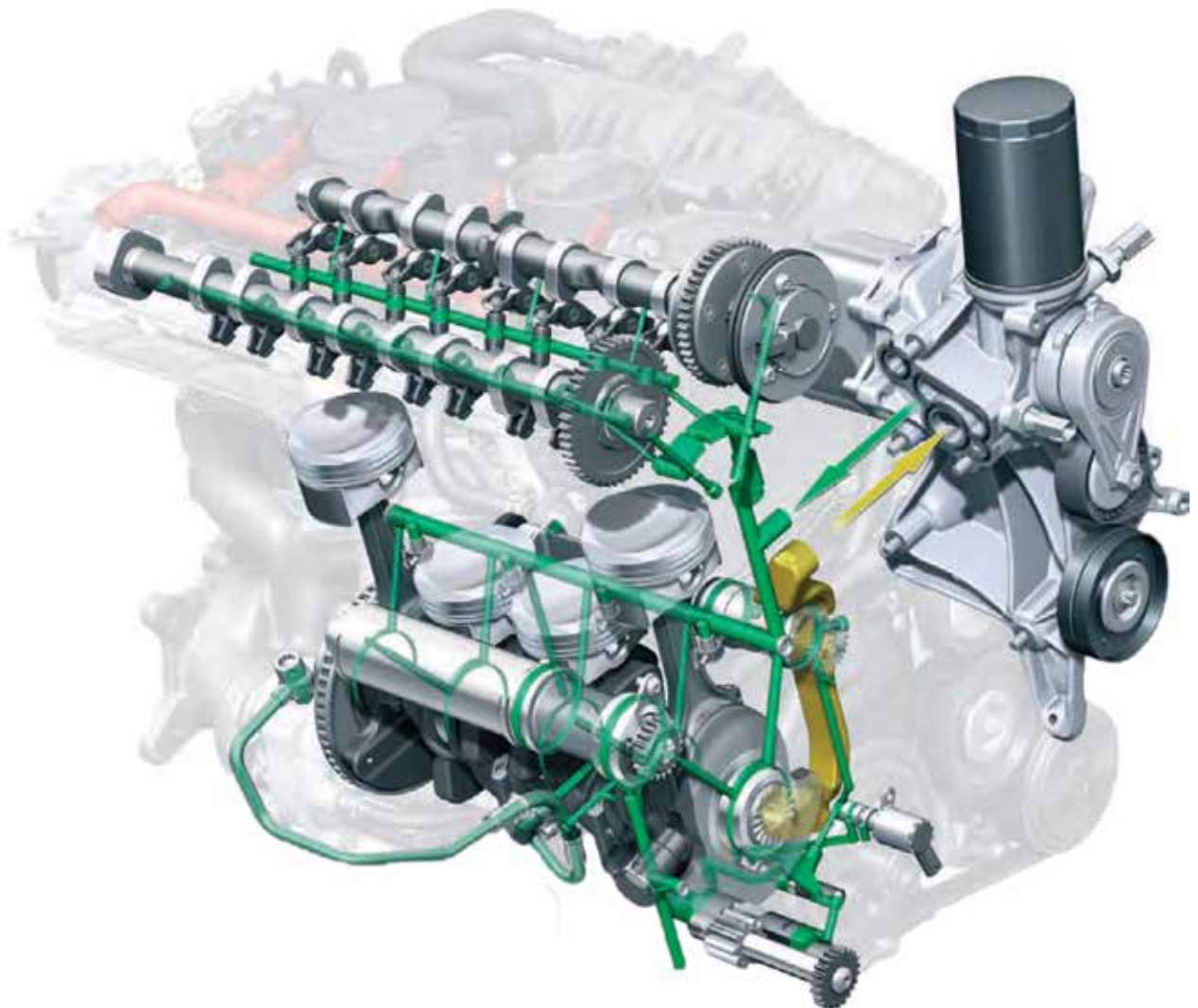


Timing chain tactics

These engines use chain-driven camshafts, so no routine replacement of fibrous timing belts is required. If you do encounter one of these engines with substantial sludge build-up, however, it is likely that the timing chain will also warrant replacement. These timing chains ride on guide rails, and if the chain is worn, then the guide rails are likely due for replacement as well. Furthermore, these engines use a hydraulic timing chain tensioner behind the guide rails, and if the chain is badly worn, it is possible that the free play in the chain exceeds the ability of the tensioner to compensate for that wear. This would be evidenced by timing chain rattle, which, sadly, is a sound that many technicians are familiar with.

Timing chain replacement on these engines is not a simple task. In addition to removal of the cylinder head, the process will also require removal of the harmonic balancer, the timing cover, and other components that restrict access to the front of the engine.

Finally, though it may be routine, and you should make it so if it is not, you should be certain to chase all threads before reassembly, and also to remove any oil or other debris or liquid from tapped holes in the block, head, and elsewhere. It is entirely possible that torquing a fastener into an obstructed hole can generate enough mechanical or hydrostatic force to crack and destroy the component the bolt is being threaded into. It's a simple step, easily overlooked, but a critically important one. ●



The oil flow through this engine is complex and circuitous, with many locations where harmful sludge can accumulate. This makes regular maintenance especially critical.

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PPG is an approved supplier to Volkswagen of America's Certified Collision Repair Facility program.



Volkswagen Certified Collision Repair Facility

+ Fixing the Car and the Process





Newer Volkswagen vehicles include extensive use of Ultra-High-Strength Steels (UHSS) and other lightweight materials, plus advanced electronics and optional rear view camera technologies that may be embedded in or attached to bumper and body panels. Collision repair service providers must update their equipment and technician training to properly repair these new materials and technologies. The Volkswagen Certified Collision Repair Facility (CCRF) program is helping collision repair service providers adapt.

The Volkswagen CCRF program provides technical information and training to help collision repair facilities better serve their customers, gives dealers a process for ensuring that they have a local collision service provider that can restore their customers' vehicles to Volkswagen specifications, and offers assurance to vehicle owners that they have brought their damaged car to the right place.

Information Is Power

The key to success is information. Automotive technology is changing almost as fast as computers. Even the best technician needs continuous training just to keep up.

Volkswagen uses advanced hot-formed high-strength and ultra-high-strength steels on many vehicle models. Each requires different repair methods.

For example, boron (a type of high-strength-steel), has a low tolerance for heat. MIG welding is not recommended due to this heat sensitivity. Instead, squeeze-type-resistance spot welding is preferred, with or without adhesive bonding and riveting, depending on the component.

If bent, boron cannot be straightened. It must be replaced as a complete structural member.

Many technicians are now aware that Squeeze-Type Resistance Spot Welding (STRSW) is the best way to weld most high-strength steel. You need application-specific training however, to know whether a structural UHSS part can be repaired or must be replaced, or where to section a part in order to help maintain the required strength of the finished repair.

You need information that tells you exactly where and how a frame rail is attached to other structural components. Without such information, you may crack or fracture a flange seam, weakening the bond and compromising the safety of the vehicle.

Worse, you may attempt to straighten a part that should only be replaced, or weld parts together that should be attached instead using adhesive bonding and riveting. Some advanced or ultra-high-strength steels respond to heat in a manner that, unlike regular steel, weakens them.

A new door may look like a traditional panel, but may be made of a material that you've never worked on, or that requires cold straightening rather than heat to remove damage. A new roof panel may feature layered construction that requires special attachment methods.

Volkswagen CCRF participants can link to VW technical and repair information, research a part, and download step-by-step repair or replacement instructions.

Winning on Price

Volkswagen wants to help ensure the use of Genuine VW parts in after-collision repairs because they help keep repair quality high. CCRF participants must use new Volkswagen parts for a minimum of 90 percent (in dollars) of the final repair order.

To help make it easier for service providers to meet insurer demands, VW offers a price matching program. Part of the VW OE Parts Connection, the program allows CCRF participants to purchase Genuine VW parts at a lower price that satisfies the insurer.

This price-matching arrangement is a wholesale support program for dealers. It is also a business-building feature for collision facilities, and it is available only to CCRF program participants.

Like a Factory Robot

As recently as fifteen years ago, most collision shops used frame machines that attached to the vehicle at each corner and perhaps a few additional points. As a result, a pull in the front may have affected measurements in the opposite corner at the rear.

Today's dedicated frame bench has many more attachment points. The technician typically pulls a section that is rarely more than a foot away from the nearest anchor point along the component's length. It is no longer necessary to inspect or measure the other end of the vehicle after every pull.

The Volkswagen Certified Collision Repair Facility program requires the use of a bench with fixtures that are specific to individual Volkswagen models. Fixtures and jigs hold the vehicle in place and help

Photos Courtesy of Jim Ellis Collision Center, a VW CCRF in Atlanta, Georgia.

allow the technician to place the structural member being repaired or replaced in only one position – with factory measurement precision.

Celette® and Car-O-Liner® are the two frame benches approved in the CCRF program. Celette® manufactures a Volkswagen-dedicated bench, and Car-O-Liner® makes a universal bench that, with optional VW-specific fixtures and jigs, can pinpoint a frame rail as well as a factory robot.

Both manufacturers develop their equipment using Volkswagen chassis blueprints. Each bench offers zero tolerance placements of structural components, and can detect damage so small that it may not easily be found with other equipment.

The model-specific jigs add time to the process of setting up the bench, so shops must recover that cost. Shop estimators present insurance adjusters with the structural component tolerance limits published in Volkswagen vehicle specifications, plus the necessity of a dedicated fixture bench to accomplish repairs within those factory tolerances. It helps adjusters recognize the need to allow extra labor time for setup.

Selling Peace of Mind

CCRF participants promote the program directly to vehicle owners as assurance that they are bringing their vehicles to the right place. They educate their customers about how their Volkswagen-trained technicians, access to OEM technical and repair information, and use of genuine Volkswagen collision parts combine to help ensure that their collision-damaged vehicle will be restored to like-new condition.

Selling peace of mind directly to the vehicle owner gives CCRF participants a potential ally in any discussion with the insurance adjuster about whether or not a specific repair procedure or part is necessary. If you've explained that the traditional frame machine is not as accurate as your company-approved dedicated Car-O-Liner® or Celette® bench, and that the genuine VW part, like a suit that has been altered to fit your body, is exactly what your customer's car needs, it helps overcome price arguments the adjuster may pitch to the vehicle owner.

The Smart Way

In addition to a frame bench that's dedicated to VW vehicles, Volkswagen lists a few other common-sense requirements for the collision repair facility. There are more special tools required, but the list below hits a few highlights.

- Fully enclosed downdraft paint spray booth

- Dedicated paint mixing room with air extraction available
- Company-approved paint supplier (see below)
- Squeeze-Type-Resistance-Spot-Welder (STRSW)
- Smart Spot Welder

VWoA Approved Paint Suppliers

- | | |
|-------------------------|-------------------------|
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Lesonal |
| •Standex | •PPG |
| •Spies Hecker | •NEXA |
| •Akzo Nobel-
Sikkens | •BASF-Glasurit |
| | •RM-Diamond |



Volkswagen provides creative signage that helps promote the CCRF program to vehicle owners.



Check your repair information for locations of sound-deadening insulation in the repair area, and replace it if missing or damaged.



Yellow arrows show where the front wheel apron is separated from the engine mount support that connects to the upper inner structure. If the dent is minor, the part may be straightened and welded. If the metal has a hard line, or kink instead of a slight depression, the apron must be replaced. If however, the metal has only a slight curvature, the damage may be light enough to allow straightening.



This factory-applied seam sealer on the wheel apron provides corrosion protection. The metal has torn in several areas, but may be repaired. It will be reattached using adhesive bonding and riveting.

A Smart Spot Welder is designed for two-sided or single-sided spot welding on multiple types of metal, including advanced high-strength steels. A smart spot welder senses the sheet thickness and material type (HSS, UHSS, boron, etc.) and automatically selects the correct weld power, time and tip pressure for the material being welded. There's no guesswork required, even where there is corrosion protection between metal layers.

Boron steel is hard enough that it can quickly wear out the cutting edges of conventional spot weld drills, cutters, and reciprocating saws. You'll need stronger spot weld bits and drill bits for making rivet holes in boron.

Volkswagen does not use a lot of aluminum for structural components and body panels. So, unlike certified collision repair programs for many other OEMs, there is no requirement for a major investment in equipment and tools for working aluminum.

Market Opportunity

Volkswagen is not putting a certified collision center on every corner. There are many markets with no, or only one or two, Volkswagen CCRF participants. In those markets, the certified shops draw business from a wider area than the typical non-certified collision repair facility.

VW dealers that have no in-house body and paint capability refer their customers with collision-damaged vehicles to CCRF shops. Independent collision shops that have not had Volkswagen repair training send vehicles with damage in sensitive areas to CCRF shops.



Note the damaged and missing paint above the weld and the impressions in the metal where the bolts were originally torqued down. The black impact bar (bumper support) has been damaged in a front collision and must be replaced to meet safety requirements. If the impact also bent the rail enough to create a kink in the metal, that can cause work hardening and brittle conditions in the damaged area. If so, the rail cannot be straightened, and must be replaced.

Smart shop owners do not want the risk that comes with working on a vehicle for which their technicians have not been trained. The liability if a structural component or electrical system is not repaired properly is a strong incentive to not take the risk.

A Certified Team

To become a certified VW collision repair center, a shop must also agree to keep its technicians up-to-date as new technology is introduced on Volkswagen vehicles. The training explains how to work with the different metals on specific vehicle models, when to use certain

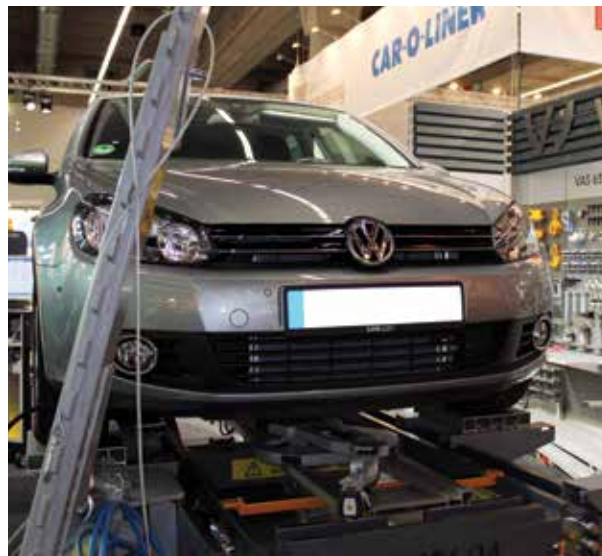
welding or adhesive bonding and riveting techniques, and how other factors such as nearby sensitive electronics may affect the choice of repair procedure.

Talk to the owners of facilities that have already qualified for the CCRF program, and they will tell you it is worth it.

Help your customers better understand collision repair issues, and the reasons that OE parts are recommended. ●



You'll need a squeeze-type-resistant-spot-welder (STRSW) such as the ElekTron® Spot Welder®, which is approved by VW. STRSW equipment can work using less heat than a MIG welder, making it flexible enough for use on a variety of metals, including ultra-high-strength steel (UHSS).



The Car-O-Liner® Quick 42 is a bench that offers the precision and durability required for collision repairs, and is approved by VW. It is compatible with specially designed fixtures in the VAS 6528 system that make it adaptable for both structural and cosmetic VW repair. Photo courtesy of Car-O-Liner®.



The Celette® bench allows quick attachment and adjustment of its straightening brackets, gauge system, cross members, towers and wedges. It positions the fixtures at the proper measurement points for precise repair on any VW model. Photo courtesy of Warren Barbee, Volkswagen Collision Training.



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Jack Daniels Motors, Inc.
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Hamilton Volkswagen
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Three County VW Corp.
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Volkswagen of Salem County
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World Volkswagen
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Volkswagen of Newton
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Trend Motors, Ltd.
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Volkswagen of Santa Fe
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Northtown Volkswagen
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Bay Ridge Volkswagen
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Volkswagen of Brooklyn
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Burdick Volkswagen
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VW of East Rochester
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