

Volkswagen Cabriolet

DIY Guide: Digifant Tune-Up

Originally posted at <http://fuelie.tripod.com/tuneup.htm>, aka Ken's Digifant Pages for A2 chassis Volkswagens.

First, a word about safety. I have become more aware over time of the need to protect myself from some of the nastier chemicals I encounter when working on cars. I have taken to wearing latex health-care type gloves. They are cheap and I'll go through two or three pairs doing brakes or a water pump. It's amazing to come out of the shed after working on cars all afternoon and only have to give my hands a quick rinse.

In addition, a lot of the chemicals and solvents we use as a matter of course have turned out to be quite dangerous. Aerosol liquid brake cleaner, for example, was invented to replace the deadly shop practice of blowing asbestos dust out of brake assemblies with compressed air, thereby ensuring that everyone in the shop got a dose of asbestos. Asbestos causes lung cancer (remember Steve McQueen?). Anyway, the replacement is a liquid spray containing perchloroethylene -- which can cause liver cancer. Ouch.

Anyway, into every life a little risk must fall, but I also realize I don't need to be foolhardy with shop chemicals. Just as a little common sense often goes a long way, so too does just a little chemical, most of the time.

Now back to our story.

[The Basics - Setting up your Digifant car](#)

If you've just bought your Digifant car or even if you've had it for years, there's little to be gained by trying to shotgun performance problems by trying everything and replacing everything. For highest performance and greatest enjoyment, work through the following sections. The steps are easy, especially if you have a manual. At the end of this process you will have spent a little money, had some fun I hope, and, odds are, your Digifant car will be running better than ever.

NOTE: All steps and suggestions in these pages assume that your engine is normally quiet-running, has good compression and is consuming virtually no oil or coolant. In other words, it is in good basic condition. You may however be experiencing hesitation, surge, erratic idle, bucking, low power, hard starts or any of a myriad of other symptoms.

Here's how to set up your Digifant car:

Ignition System

No car runs flawlessly forever. So before you begin blaming VW gremlins on Digifant design, start by examining and verifying all the traditional trouble spots you would suspect in any car. Start with the ignition system:

[Spark Plugs](#)

Your spark plugs should be of the correct type for your car. VW recommends Bosch WR7DS* (S for Silver electrode) for the Digifant engines. There are plenty of arguments about silver and platinum electrodes. Call me a heretic, but I have found copper-electrode plugs (Bosch WR7DC*) work just fine, give good life and are much cheaper.

Whatever plugs you choose, make sure they are gapped to 0.7 mm (~0.25 in.*). Put a drop or two of engine oil on the threads (not on the electrodes!) before you install them and don't over-tighten them. Check your plugs a couple of time a year for gap and signs of wear or oil-fouling. Like all modern engines, spark plugs in a healthy Digifant engine should have a brownish-tan appearance.

**Ed. note: This literature is out of date. Use the NGK equivalent. SAE plug gap for Cabriolets is 0.28".*

[Plug Wires](#)

Worn out plug wires can reduce or interrupt spark delivery to the spark plugs. Insulation softened by temperature extremes, oil and grease, and time can allow arcing which causes misfiring.

If you suspect your plug wires are not up to the job, wait until after dark. Start the engine and using a common household pump bottle, lightly spray a mist of water over the plug wires. You may notice erratic engine operation right away, accompanied by sparks jumping from wire to wire or from wire to engine metal as the water spray conducts current away from its proper path. The solution here will be obvious.

Replace plug wires when they begin to look really grimy to eliminate this potential trouble spot.

Distributor Cap and Rotor

Over time, the interior of a distributor cap will build up deposits of carbon called "tracks". Carbon is an electrical conductor and will interfere with the orderly distribution of current to the spark plugs. Remove the cap and rotor and look inside. Any black, grimy substance in there is carbon tracking. In addition, the copper contacts inside the distributor cap should not appear burned or scorched. If the cap is relatively new, clean up the contacts with some fine sandpaper, then wash out the carbon tracks with hot soapy water, dry and re-use the cap.

Look at the rotor too. Burnt or scorched copper rotor contacts can also be cleaned with fine sandpaper, but if the cap and rotor appear to be in generally bad shape, or if you've done the hot water and sandpaper routine before, it's time to replace them.

While you're checking out the distributor, have a look at the Hall Sender plug on the front of the distributor. The insulation should be intact. Remove the boot and give the plug contacts a shot of contact cleaner and a dollop of Stabilant if you are feeling generous.

Timing

Setting the timing on a Digifant engine is slightly different than other systems. Whereas most cars have the timing set with the engine at idle, Digifant timing is accomplished with the engine turning between 2000 and 2500 rpm. This fools a lot of professional mechanics and hobbyists alike who are experienced with CIS and CIS-E systems which must be timed at idle.

Before you set the timing, disconnect the blue coolant temperature sensor in the cylinder head coolant neck. Rev the engine through 2500 rpm four times to clear the control unit's memory. Loosen the distributor hold-down bolt. Watch out for the radiator fan which can come on at any time during this procedure.

Set the timing to 6 degrees +/- 1 degree before top dead center at approximately 2250 rpm. Tighten the distributor hold-down bolt, and rev the engine through 3000 rpm three times.

Now you should check and reset your idle speed if necessary. The correct idle with the coolant temperature sensor disconnected is 900 to 1000 rpm. With the sensor connected normal idle should drop to 800 +/- 50 rpm.

For Digifant I cars only, you must reset the control unit to its base setting after adjusting the timing. See your factory manual.

Although some cars respond to advanced timing, Digifant does not and needs to be timed to the factory setting for peak performance and to avoid ping. Even with the correct timing, Digifant cars run best on 92 octane fuel or better and may still ping on hot days due to hot spots in the cylinder head.

Temporary solutions to hot weather ping include increasing the amount of water in your antifreeze mix, adding a surfactant (wetting agent) to the coolant such as Red Line's Water Wetter, installing a lower temperature thermostat.

Emissions System

The oxygen sensor, catalytic converter, PCV valve and fuel evaporation controls are the main emissions-related equipment on Digifant cars. Because of its role in controlling mixture, the ECU can also be considered part of the emissions control system.

Oxygen Sensor

The oxygen sensor measures the amount of oxygen in the exhaust gas flow signaling the ECU to lean or richen the mixture. VW recommends replacing the O2 sensor every 100,000 kilometers (60,000 miles).

Obvious symptoms of O₂ sensor failure include black exhaust smoke, rough running and plummeting fuel economy. Not so obvious symptoms can include lean running which may cause backfiring in the intake, quirky throttle response, overheating and detonation.

See your Bentley manual for electrical procedures for testing an O₂ sensor. A shade tree test is to simply disconnect the O₂ sensor and go for a drive. If you notice a marked improvement in the way your car drives, install a new sensor. Although it is tempting to keep the sensor disconnected, without its input, the ECU cannot control the mixture. The ECU will revert to a programmed-in rich mixture which will eventually destroy your catalytic converter.

One other thing about oxygen sensors. If your symptoms go away once the car is warmed up, your oxygen sensor is not to blame. It does not function until it gets hot enough and that is not until the engine has been running for a while.

If you have never replaced the O₂ sensor on your car, you may be surprised at the difference a new one can make. Lots of Digifant quirks can be tamed or eliminated with a new O₂ sensor.

The factory Bosch oxygen sensor with a new connector is relatively expensive. You can buy a universal sensor and splice your old connector to it for a less expensive solution.

Catalytic converter

Catalytic converters are essential for cleaning the exhaust after the ECU and O₂ sensor do their bit in creating the optimum conditions for maximum power, best fuel economy and cleanest exhaust.

Given a failed oxygen sensor, the cat can plug up overtime creating back pressure and restricting power. Eventually it will overheat and the internal substrate will melt and break up.

If you hear a rattle like the sound of marbles in a can under your car with the engine running, first check for a loose heat shield, but then suspect a melted cat. Again, don't be tempted to "gut the cat". Without a catalytic converter, your car will pollute the atmosphere as much as 100 cars with good cats.

PCV Valve

The Positive Crankcase Ventilation Valve is described below under the heading Vacuum Leaks.

Evaporative Emissions Controls

The Evaporative Emissions Control system keeps gasoline that vaporizes from the fuel system from escaping to the atmosphere. Vapor from the tank is fed to a carbon-filled canister under the right front fender. Vacuum hoses run to the canister and can be a source of vacuum leaks.

Fuel System

Fuel Pumps

Like most A2s, Digifant cars have two fuel pumps: the transfer pump inside the fuel tank supplies fuel to the main pump reservoir. The transfer pump is identical to the CIS-E unit. The main pump and reservoir assembly is located under the car ahead of the right rear wheel.

Should you use Gas-Line Antifreeze?

In the Canadian winter, water inexorably finds its way into gasoline. Any filler or opening that can be covered with snow, from the oil refinery to the car's filler cap is a potential point of entry for water in the fuel. In winter, symptoms such as hard starting and poor driveability can often be traced back to water-contaminated gas, especially if you have filled the tank during a snow storm. The cure is to pour a 250 ml bottle of gas-line antifreeze (often mis-named dry gas) into the tank before you begin to refuel (to ensure even mixing). Use gas-line antifreeze at every fill-up for the entire period of heavy snow.

Throttle Switches

The Digifant system uses a pair of throttle switches on the throttle body to report wide open throttle (WOT) and closed throttle conditions to the ECU. The WOT switch is easily seen on the rear top of the throttle body. As the throttle linkage achieves maximum travel, a cam on the linkage opens the WOT switch, signaling the ECU to richen the mixture for maximum power. The closed throttle switch is located underneath the throttle body. When the throttle closes It signals the ECU to run its idle program.

Failures here are very rare but both of these switches may fail or fall out of alignment. If the WOT switch is at fault, maximum power may not be available. If the closed throttle switch fails, the car may refuse to idle or may buck and jump at low throttle openings, regardless of speed.

Vacuum Leaks

VWs are not generally cursed with the spaghetti of vacuum lines found under the hoods of many other cars. Nevertheless, vacuum lines are used in VWs and can cause trouble from time to time - creating the so-called "false" air syndrome.

Air entering the engine that is unmeasured by the fuel injection system's air flow sensor is known as "false" air and will tend to lean out the engine's carefully controlled air-fuel ratio. Symptoms may include hesitation, bucking, poor throttle response, surging at small throttle openings and power loss. Serious vacuum leaks will play havoc with driveability as well as the operation of vacuum operated devices including power brakes, air conditioning vent flaps and power locks.

A vacuum leak can occur anywhere there is a joint or fitting that connects directly to the intake air flow, along the length of any plastic or rubber vacuum hose, around a worn-out valve cover gasket or around the fuel injector seals. Especially look for hoses that may have chafed through from continually rubbing on something.

Other Potential Vacuum Leaks

- Evaporative Emissions Control Canister
- Air Conditioning
- Vacuum powered door locks
- Dipstick

Air Flow Sensor

Start your hunt for vacuum leaks at the Digifant air flow sensor/air filter housing. Check the rubber duct between the air flow sensor and the throttle body for signs of splits or cracking. Cracks in the duct may only open up under acceleration when the engine torques rearward in its mounts.

Remove the duct and inspect it carefully, twisting it in your hands (remember your gloves) while you look for cracks or splits. Reinstall the duct, making sure it seats correctly on the air flow sensor and the throttle body and that the hose clamps are not cocked or pinching the rubber when you snug them down. A light smear of clean oil on the metal mating surfaces can ease the installation of the duct.

Temperature Regulator Valve

The temperature regulator (or preheat) valve is located in the air flow sensor box above the air filter. The regulator valve's purpose is to control the operation of a flap in the air box which diverts heated air from around the exhaust manifold to the intake during starting in cold ambient temperatures.

The regulator valve has two vacuum fittings which protrude through the side of the air box. A short vacuum line of white plastic runs from the lower fitting on the box to the diaphragm which controls the intake preheat valve. A longer vacuum supply hose runs from the upper fitting on the box to the throttle valve. A tee in this hose splits off to the fuel pressure regulator, which is located at the right (passenger) end of the fuel rail. Check all of these lines for chafing, holes and snug connections.

PCV Valve

The positive crankcase ventilation valve (PCV) is another potential source of vacuum leaks. The PCV sits on the valve cover. The crankcase ventilation hose which connects to the PCV should be clean and free of cracks or splits. Follow the hose to where it connects to the throttle valve and make sure the connection is tight. The hose clamps should be in good condition and properly snugged down, but not so tight that they bite or cut into the rubber. Check the rubber grommet in the valve cover where the PCV mounts for a snug fit. The grommet should be free of cracks or other visible injury. See below for instructions on cleaning the PCV valve.

Power Brake Booster

With your engine off, step on the brake pedal eight or ten times to let air into the power brake vacuum booster. Now, hold down the brake pedal and start the engine. The pedal should drop slightly as vacuum builds in the brake booster. Vacuum leaks in the brake booster are exceedingly rare. Suspect other sources first.

Just Plain Dirt

The inside of a Digifant engine, even a clean running one, will eventually be a pretty grimy place. Positive crankcase emission control virtually guarantees that a film of grease will eventually coat the PCV valve, the interior of the Idle Stabilizer Valve and the Throttle Body. Dirt in any number of places can cause driveability problems or make existing problems worse, so read on and make sure a thorough clean-up of the affected parts is on your troubleshooting list.

Air Filter

Remove your air filter from the air box and hold it up to the sun or other strong light. If light shines through the folds in the paper, the filter is OK. Replace it when it becomes opaque. While you have the filter out, check the air box for debris. Chipmunks are known to stash acorns and seeds in the air box if the car is parked for more than a few days (happened to me!).

Fuel Filter

A key element of any fuel injection system is the fuel filter. Unlike the A1 cars which had the fuel filter up in the engine compartment close to the fuel distributor, the Digifant fuel filter is attached to the fuel pump reservoir, under the car just ahead of the right rear wheel.

The Bentley manual specifies that the Digifant fuel filter should be replaced every 2 years or 48,000 kms (30,000 miles). According to Bentley, this is maintenance "recommended by the publisher which meets or exceeds Volkswagen requirements". By contrast, VW maintains that Digifant uses a "lifetime filter" that only needs to be replaced if it gets contaminated.

If the fuel filter does become contaminated by water, dirty gas etc., engine performance suffers. Flow restriction at the filter can overtax the fuel pumps possibly causing one of the pumps to seize. Replacing the fuel filter every two years is probably a good idea, despite VW's advice.

Be careful removing the filter. The Digifant fuel system is pressurized even with the ignition off. Loosen the gas cap, pinch off the hoses leading in and out of the filter and wrap a rag around the fittings before you loosen them. This will help avoid a high pressure jet of gasoline soaking your eyes or something flammable.

Fuel Injectors

Fuel Injectors can become restricted over time or after high mileage. If fouled with dirt, injectors can cause the engine to run either lean or rich. Save your injectors by changing your fuel filter as needed. In addition, run two 250 ml bottles of fuel injector cleaner through the system twice a year.

Idle Stabilizer Valve (ISV)

Dirt in the Idle Stabilizer Valve (ISV) is a likely cause of erratic idling and stalling, especially when the air conditioner compressor cuts in. A dirty ISV will cause the car to not idle at all, or may cause the idle to lope up and down between 700 and 1500 RPM.

The ISV sits on top of the engine just behind the valve cover and in front of the intake manifold. It is designed to allow a metered amount of air to bypass the throttle valves depending on engine load, temperature etc. to maintain an even idle speed.

To clean the ISV, remove the valve from the engine. Spray the ISV liberally with carburetor cleaner or throttle body cleaner. Use rubber gloves and work outdoors because this cleaner may contain toluene or xylene or both. These chemicals are extremely nasty.

Don't use brake cleaner - it can destroy plastics and rubber. Also, brake cleaner contains perchloroethylene, an even scarier chemical. Definitely try to avoid breathing any of this stuff.

After taking precautions, spray the cleaner into all three openings in the ISV and allow the black gunk inside to drain out. Carefully use a small piece of wood as a scraper to clean up the interior of the valve. Try to get the metal inside as clean as possible. Spray again and repeat until it sparkles inside.

ISVs do fail outright and then you are faced with an relatively expensive fix. At least the part is easy to replace. But before installing a new ISV, always try carefully cleaning the old one first.

A properly working Digifant idle stabilizer is effective enough to allow a manual transmission car to creep along at idle speed without stalling.

Throttle Body

Another place to spray cleaner is into the throttle body (TB). Remove the rubber intake boot from the TB and spray carburetor- or throttle body cleaner inside. A film of greasy black grime is normal after a year or so of driving. If the TB has never been cleaned, it could be really black with dirt.

Spray down both throttle butterflies and the walls of the TB. Make sure the inside of the TB is clean and shiny. Stuff a rag under the TB to keep the gunk that runs out from dripping onto the exhaust manifold. Don't worry if some of the spray goes in past the butterflies, it'll burn off.

Now look for the idle speed adjustment screw on the front of the throttle body. Using a small screwdriver, back the idle screw out. Carefully count the number of turns it takes to remove the screw and make a note of the number of turns. Now spray your cleaner into the machined orifice into which the screw fits. Carefully give the screw itself a shot of cleaner too. Make everything clean and shiny. Replace the screw in its orifice and turn it back in by the same number of turns it took to remove it. Don't worry about fine tuning right now, that will come later.

If the TB seems to be very greasy, or if there is oil pooling in the TB or the rubber intake duct, suspect a problem with crankcase ventilation. If large amounts of oil or blow-by gases are making it to the intake you probably should consider doing a compression check to see which cylinder is the culprit.

Take the opportunity to inspect the rubber intake boot for cracks, then carefully seat the rubber boot back onto the TB and snug down the clamp making sure it doesn't cock or bite into the rubber.

Positive Crankcase Ventilation Valve (PCV)

The PCV valve sits in a rubber grommet in a hole in the valve cover on the driver's side of the engine. It is a flat plastic can with a rubber hose that connects it to the idle stabilizer valve. The PCV valve routes blow-by gases that get past the piston rings back into the intake where they are recycled for cleaner emissions performance.

Use carb cleaner on the PCV valve just as you did on the ISV. To avoid vacuum leaks, make sure the PCV seats snugly in its rubber grommet in the valve cover and make sure the hose to the throttle body is snug at both ends and free of cracks or holes.

Corrosion of Electrical Terminals

The ECU connectors are a first place to start when troubleshooting. Find the ECU under the left cowl. Remove the drip trays for access. With the ignition off, free the broad flat multiple-connectors from the ECU and the ignition control unit. Removing the connectors is easier if you unbolt the control units from their mounting brackets. Make sure the connections are dry.

Check the electrical connections of every sensor for tight fit and signs of corrosion. Gently clean the connectors with electrical contact cleaner from an electronic supply house.

Also do a visual check of all ground connections. Your battery light should go out immediately after starting. If not, check the negative wire connection at the battery. Grounds are located behind the battery, at the engine block and at a nut on the rear driver's-side valve cover, among other places. The ground at the valve cover is especially important for smooth Digifant operation.

Clean up all ground connections with a wire brush or sandpaper. Use VW-approved Stabilant 22A on the contacts for a long-lasting job.

A few notes about Stabilant 22A:

Stabilant is a Canadian-made substance used to enhance conductivity while sealing out moisture. The VW part number is ZVW 186 001 STABILANT 22A. According to VW you should NOT apply Stabilant to oxygen sensor terminals.

If you disconnect a connector you must reapply Stabilant.

Stabilant conducts electricity as well as a soldered joint.

Stabilant has the interesting property of enhancing conductivity between two connectors but remaining a non-conductor between adjacent terminals in a multi-pin connector.

Stabilant's Web site is www.stabilant.com . (Their product is far superior to their Web presence.)

Ye Olde "Italian Tune Up"

(not for the faint-hearted)

Consider the German heritage of your Volkswagen. Because of the high speed Autobahns, all VWs have been designed to run effortlessly at prolonged high speeds since Day One.

But today most owners trundle their VWs short distances through stop and go rush-hour traffic at low speeds. The opportunity to get the engine up on the cam and run it until good and hot is rare.

As a result, engine oil doesn't get hot enough to boil off moisture and burn off the deposits caused by low speeds and incomplete warm-ups. Even with a fresh cleaning and tune-up, these cars may still show poor idle step-off, hesitation and non-linear throttle response.

A cure can sometimes be to carefully run an otherwise good engine hard so it gets hot enough to burn the excess carbon deposits off the piston crowns, clean the valve faces and blast deposits off the spark plugs, fuel injector nozzles and oxygen sensor and at the same time boil any lingering water out of the oil.

WARNING #1:

The following procedure can blow your engine to: smithereens, bits, pieces, orts, perdition and kingdom-come. If you own a high-mileage, low-compression, oil-swilling, rod-knocking, piece o' crap car (you know who you are, don't you), don't bother with the "Italian Tune Up" because you will end up walking home from what's left of your sorry pile of smoking and hissing ex-VW junk. OK? (I'm not kidding.)

:-)

Now, assuming your car is otherwise in healthy condition already, and you have worked through the other steps on this site, let's begin.

The easiest way to "blow out the carbon" is to run the car under load at high engine speed. In other words, run the car right to the redline and hold it there in every gear. For decades, experienced drivers and mechanics have called this procedure the "Italian Tune Up".

Now this is a great trick on a race track, but hardly practical on the street.

The street alternative is to first check all fluids and top them up. Make sure you are running clean, high quality oil. I use regular dino-oil 20W50 in summer, 10W30 in winter. (A lot of experienced drivers swear by synthetic motor oils for high temperature running. The additional expense of synthetics may be offset by their longer drain intervals.)

Drive a while so that your oil and water temperatures rise into the normal zones, then head out to your local four-lane. In light or no traffic, try to run for one or two minutes at 90 to 100 kph (~ 55 to 60 mph) in second gear. The engine will be running (loudly) near the red line.

If you continue to push up into the red you will trigger the Digifant rev limiter which cuts the fuel supply in half. This will feel like a sudden roughness in the engine and a loss of power. The first time you experience this you may think you've blown something. Just back out of the throttle so you don't keep banging into the rev limiter. If your engine is in good shape, this is not dangerous, just disconcerting the first time you experience it.

Again, neglected engines will not be up to the strain. If you really don't know the maintenance history of your Digifant car, or if you've just bought it, do not attempt this!

WARNING #2:

If you blow a head gasket or otherwise detonate your engine by following this procedure, don't say you weren't warned! Because you have been warned.

Now if you feather the throttle back just out of rev limiter range and hold it there for 60 seconds or so, the car will continue to cruise smoothly, albeit loudly. (If you are not used to driving your car at or near the redline, the noise can be disconcerting, especially to your passengers!).

The point of holding the rpms steady under the red line is

to get everything really hot from the piston tops and valve faces out to the catalytic converter. Under these conditions the engine will quickly reach peak operating temperatures.

I have this vision of four wonderfully hot whitish blue flames pouring out of each exhaust port into the downpipe. Sort of like getting the mixture just right on a Bunsen burner or an oxyacetylene torch, or how about on a 1650 hp Rolls Royce Merlin V12 at just under "war emergency" power? Nice!

If you have an oil temperature gauge, keep a close eye on it because depending on the ambient air temperature, this should be as high as it will ever get. In my Jetta on a warmish summer day, oil temperature peaks around 110°C (~230° F). That's hot!

Remember, if your car is in basically good shape to begin the red line is fairly conservative. A kilometer (or mile) or two of this is all you need to burn off the harmful deposits from stop and go driving. At 100 kph (~62 mph) and 6,000 rpm, a 60 to 90 second burst should be all you need.

After one or two such treatments, the improvement in Digifant low speed driveability and throttle transitions may be quite noticeable, especially after a few months of winter or just city driving.

Remember, the famous "Italian Tune Up" is meant only for drivers who know their cars well and know that their cars are in good shape. If you don't know whether your car is up to this kind of treatment, or if you can't afford to fix it if it blows up, then don't risk it.

After all of this, your Digifant car should be running like a champ.
