

## **Late-model Mexican Beetles and The ACD Air-Cooled Engine**

### **Disclaimers, etc.**

This is NOT an official service manual, and the information and procedures contained herein have been gathered from various unofficial sources. Technical information for the modern Mexican fuel-injected air-cooled engine has been nearly impossible to find, leaving those of us who do not live in Mexico without the resources to properly maintain and repair our vehicles. Fortunately the engines are extremely reliable and require less adjustment than the “classic” cars of the 60s and 70s. (I’ve driven mine daily for 3 years, and it has needed only oil and filter changes.) But when something does go wrong... Having accumulated the various specifications and some procedures, and by experimenting where procedures were not described, I’ve put this data together to help me maintain my cars. Due to many requests I’ve decided to make this available to aid other owners as well. However, not all information may be accurate, and I assume no liability either for the correctness of the information or any damage or harm that may result from using the information and procedures contained herein. Besides, with my few resources and no insurance, a lawsuit wouldn’t be worth your time anyway.

The author has no association with any Volkswagen company, and use of trademarked terms are purely for identification, and in no way imply any connection or endorsement of a Volkswagen legal entity.

This is not intended to be training in engine management systems and diagnostics for an owner of the older carbureted cars. The procedures used are similar to those for modern VW models using computerized engine management systems, and this is intended to be an aid for technicians already familiar with the general procedures so they can apply their expertise to the air-cooled engines. Mechanics unfamiliar with these systems and procedures can gain understanding from readily available sources, such as the “Scan Tool Companion” and other publications from Bentley Publishers. The Bentley website technical forums ([www.bentleypublishers.com](http://www.bentleypublishers.com)) are also an excellent resource.

### **Introduction**

Those of us who drove early 60’s Beetles when they were new have always felt “connected” to them; and as we have lived with the more complex (and comfortable) modern cars have longed for the simple transportation of the Beetle. Eventually many of us bought and “restored” old Beetles, and found that 35 year-old carburetors and ignition systems aren’t as reliable as we remembered. We also may feel guilty about the relatively “dirty” exhaust of the old cars, although with so few on the road this is more of a symbolic issue than a problem. Wouldn’t it be nice to have a “new” old Beetle with a solid, clean-running engine without fussy carburetors and distributors?

Along came Btlmex and others who could take your old, U.S. registered Beetle and put on a brand-new Mexican-made body and running gear. You could even fit the new ACD fuel-injected engine, replacing the troublesome fuel and ignition systems with a very trouble-free electronic Digifant engine management system, and with a Lambda sensor and triple-catalytic converter to make the old Beetle (you would be driving anyway) a clean-running and reliable vehicle. The restored car also had improved brakes, modern seat belts and seats, and even an alarm and anti-theft system. While they did not have airbags and other modern U.S.-mandated crash-protection systems, they met all requirements for the time the car was originally imported, and could therefore continue to be licensed and driven.

The car still has the simple, basic transportation feel of the Beetle, with the least reliable systems replaced with solid modern technology. You end up safer and cleaner than continuing to drive the car with the original aging parts, so this is a real win-win situation.

As long as none of the new electronic systems has a problem and needs to go back to a dealer in Mexico...

Luckily, the Digifant system of these cars has built-in communication and diagnostics, so that a standard interface like the VAG1552 can connect and read any stored trouble codes (DTCs) to help find problems, and can also be used to make adjustments if they are required. Some procedures are common to other VAG models, and some are unique to this model.

If replacement parts are needed, it can be a problem, especially in the USA. I understand VWoA doesn't special order parts that are not used on US models; but the VW dealers in other world areas may be able to do so. Some of the parts are also used on other VW cars of the 90s and are available from US dealers. Some are unique to this model, and you may need to go to a Mexican dealer to get them. If you plan to keep your car a long time, you may want to get and keep spares of key parts. [www.btlmex.com](http://www.btlmex.com) does list some parts, and may be able to get others, but there is no guarantee how long the parts business will be viable for them to continue.

I hope you find the following information useful.

Tom Brunson  
(Aging VW owner and enthusiast)

## General Information

The air-cooled “Sedan” model produced by Volkswagen Mexico in the 1993-2003 years used the classic 1600 engine with some updated components. It is known as the “ACD” code engine.

Differences from the engines in older models include:

1. Hydraulic valve lifters similar to the type 4 and waterboxer lifters are used, so valves stay in adjustment and should not be adjusted between rebuilds.
2. Revised cylinder heads that take a ¾” reach sparkplug.
3. A full-flow filter pump is used with larger (30mm) gears for higher oil flow. This provides better filtering to avoid fouling the hydraulic lifters. Because of the higher oil flow, pressure is better maintained in hot climates. Factory spec oil is 15w40 for the Mexican climate range; but in a wider temperature climate a 5w40 or 0w40 synthetic is more appropriate. The 70s dual relief oil pressure control is used. The spin-on filter is the same as used by most water-cooled VW 4-cyl engines, and the anti-drain back of the Vanagon waterboxer filter (070 115 561) is helpful. (OEM are Mann or Mahle brand, available from busdepot.com.)
4. An electronic ignition distributor is used with no advance mechanism. (043 905 205 N) Ignition advance is controlled by the electronic Engine Control Unit.
5. A combined ignition coil/spark control unit is used. (\*6N0 905 104)
6. No thermostat or air shutters are used in the cooling system, as the ECU controls mixture during warmup to prevent fuel washing the cylinder walls. However, the fan shroud design has not changed, and the shutters and thermostat can be fitted (by drilling and tapping the case for the thermostat mounting stud) to provide better airflow for cold defrost of the windshield.
7. Fuel and ignition are controlled by a Digifant 1.82 ECU system. This system is unique to the air-cooled engine, although similar in concept and procedures to many VW cars. The control unit includes non-volatile memory for storing adaptation values matching the ECU to the car sensors, and for storing fault codes for diagnostics. System components include the following: (see Fig 1 for locations) [Parts marked with \* are available from US dealers.]
  - a. Digifant ECU (J169) mounted under the rear seat on the left. (043 906 022 E)
  - b. Center mounted throttle body (1B0 133 061)
  - c. Throttle position sensor G88. (\*044 907 385 A)
  - d. Intake air temperature G42. (1HM 906 501)
  - e. Dual-tube intake manifold without pre-heat pipes, as fuel injectors are at the heads. (BAA 129 711, BAA 129 705, BAA 129 706, and 2ea BAA 129 729 A)
  - f. Port fuel injectors (N30-33) (BAA 906 031)
  - g. Manifold pressure sensor (in the J169 ECU under the seat, with vacuum line to manifold.)
  - h. Hall sender (G40) in distributor. (Distributor 043 905 205 N )
  - i. Engine Temperature Sender (G27) in head at cylinder #4. (113 906 161)
  - j. Idle speed control valve (N71) controls air around throttle body. (\*048 133 455)

- k. EVAP system vent valve (N80) from charcoal canister. (\*034 133 517)
- l. Fuel pump relay (J17)
- m. High-pressure fuel pump mounted to frame head. (043 919 051)
- n. 4-wire Lambda (OXS) sensor (G39) at inlet to CAT converter. (043 906 265 B)
- o. Combined CAT and muffler, which fit standard heater boxers. (Part Number 043 253 702 C)

Figure 1 ACD engine systems



8. An electronic immobilizer is included on most cars that disconnects the ECU and starter if the correct electronic “key” is not present. Some models use a key-fob that must be inserted momentarily into a slot on the dash before starting the car, while others use an RF wand that is sensed without direct contact. Unlike modern US models, this is not built into the actual key, so keys can be duplicated. This is NOT built into the Digifant controller – it is a different unit.

Most of the engine is identical to the air-cooled Beetles of the 70s, and repair procedures are similar. However the valves should not be adjusted periodically, and are set like the T4 hydraulic lifters (0 clearance plus 1-turn compression) when assembling. The hydraulic lifters may bleed down and clatter a bit when the car sits, but they should not be adjusted if this happens. Doing so could collapse them fully and hold valves open. They will pump back up with time as the oil thins with heat to work back into the lifter.

Idle speed is controlled electronically, with no mechanical adjustments on the throttle body. When fully warmed up the idle speed should be 830 (760-890) rpm.

The Digifant ECU also limits the maximum engine speed to 5000 rpm. This controlled maximum speed allows the use of the cast steel crank and flywheel. The use of cast steel components is very acceptable for the stock engine, and has proved as reliable as forgings with the stock power and engine speed limited by the Digifant system. Modern casting methods and alloys are far superior and more consistent than when VW tried and abandoned cast cranks in early Beetle production.

There are two major adjustments in engine operation:

1. Ignition timing, which is set by turning the distributor as with older models. The one timing mark on the ACD pulley is at TDC, although the timing is set to 6 degrees btdc. This means either a digital advance timing light must be used for the setting, or a degree pulley may be temporarily installed. In normal operation the ECU adjusts timing, so this must be disabled by using the VAG1552 or VAG-COM to check or adjust timing. Ignition timing does not normally change with age and wear, and should not require periodic adjustment.
2. A “Basic Setting” procedure which matches the ECU to the throttle body and engine sensors, storing the adaptation value in non-volatile memory so it is not lost if the battery is disconnected. This procedure is covered in detail in a following section.

Because of the spin-on oil filter, recommended oil change intervals are extended compared to earlier Beetles, up to 7500 km (4600 miles) as on other VW car models.

### Engine Specifications

Power rating	34 KW (44 hp) at 4000 rpm
Max torque	98.1 Nm (132 ft-lb) at 2200 rpm
Displacement:	1584 cc
Bore	85.5 mm
Stroke	69 mm
Compression	7.75:1
Fuel Required:	87 AKI (regular unleaded)
Rated fuel mileage	13.9 km/l (32.5 US mpg)
Max cruising speed:	127 kph (78 mph)
Spark Plugs	NGK BP5ES-A (3/4” thread length); Champion N12Y (VW part # 101 000 047 AA – set of 4)
Plug electrode gap	0.7 mm (0.028”)
Engine Oil Capacity	3.0 liters (3.2 US qt) with filter change

## Fuel Supply System Overview

The ACD engine requires fuel pressure at the injectors to maintain a constant pressure above the manifold pressure. The fuel pump delivers a near constant volume of fuel, which is more than the stock engine can use under any condition. A pressure regulator at the engine bypasses the excess fuel back to the fuel pump, holding a constant pressure (above manifold) on the system. This assures that quantity of fuel injected is proportional to the duration of the injection pulse, and doesn't have to also compensate for varying fuel and manifold pressure.



The recirculation of excess fuel is different from other models. Most systems (including the FI Beetles of 1975-1980) send the excess fuel directly back to the fuel tank through a second fuel tap in the tank. The ACD system was designed so the familiar single-tap fuel tank could be used. This is done by using a special fuel pump design, so access to a spare fuel pump is a good idea if you plan to keep your car many years. (However the pump appears to be very reliable – so this may be overly cautious.)

The pump is large compared to most cars, and is mounted on the right frame head under the tank. It has 4 hose connections: an inlet from the tank; an outlet to the engine; a return line from the engine; and a vent line to the vapor venting system that feeds back into the tank fill connection. The pump location under the tank and vent system makes this single-outlet fuel tank concept work well.

This also means that two fuel lines are run through the frame tunnel to the engine. The Mexican chassis uses two 7mm steel lines. Retrofitted chassis may either use two new metal lines, or use the original 5mm fuel line and a new line. The capacity of the original 5mm line is of course less than the 7mm lines expected by the ACD design; but many of the converted cars use it without obvious problems.

Many conversions use copper tubing for the new fuel lines, often running through plastic tubing to prevent rattles. If copper tubing is used check to see that it is well secured and supported, as copper work-hardens from vibration and can eventually fail from fatigue.

The line supplying fuel from the pump to the engine exits to a hose going to a can-type fuel filter mounted to the bottom of the rear parcel shelf above the rear torsion bar. This should be a long-lasting part; but is also a good candidate to keep spares. Factory recommendation is 60,000 km replacement. From the filter another hose runs to the “fuel loop” of the engine, going to the injector rails, then to the pressure regulator, and back to the return line going up the tunnel to the pump.

The fuel injectors are located at the manifolds on the cylinder heads, and inject directly at the intake ports. This vaporizes the fuel at the heads, which helps cool the heads, and prevents fuel condensation in the intake manifold, so no manifold heating is necessary.

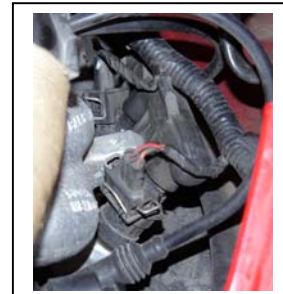
Fuel injectors can clog from very small amounts of foreign material, so anytime it is necessary to open the supply lines beyond the fuel filter the area should be well cleaned prior to opening the lines, and extreme care taken to keep dirt out. The ACD injectors are not available from US dealers, so consider keeping a spare.



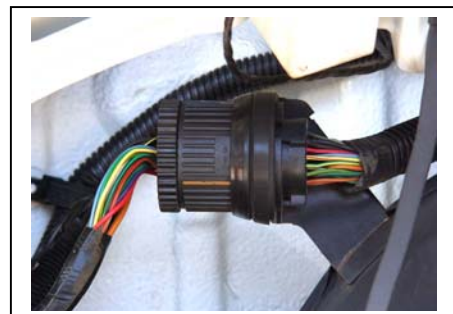
## Engine Removal.

Removing the engine is very similar to older Beetles, with attention to a few extra details:

1. Disconnect both fuel hoses to the engine: one at the fuel filter, the other at the return tube to the front. Plug all open ends.
2. The fuel rails and injectors can be damaged by the bodywork around the engine seal, and make removal and installation very difficult unless the rails and injectors are removed first. Remove the mounting bolt from the rail, and then pull the two injectors and rail out as a unit and place on the head away from the bodywork, leaving the fuel lines connected. Note the injectors are not fastened in the rail or in the manifold, but “float” on o-ring seals between them, so they may fall out of the rails as you move them.
3. You may find it easier to remove the muffler-cat assembly from the engine and heater boxes before removing the engine. This gives more clearance for the engine to move to the rear to clear the transmission. If you choose to do this, remove the Oxygen Sensor from the cat first. The electrical connector for the sensor will not fit through the grommet in the rear engine tin; the sensor will fit through once removed.



4. The main electrical harness for the engine now connects with a single round connector on top of the shroud. Twist the broad knurled locking collar and it disconnects the car harness from the engine harness



5. A wire from the engine harness goes through the front tin to the starter. Disconnect this at the starter when removing the engine.

## Hydraulic Lifters

The hydraulic lifters are a proven design, having been used on the T4 engines and Wasserboxers since 1978. They are necessary for the ACD engine, as variations in valve clearance affect emissions and can cause damage to the catalytic converter. The hydraulic lifters keep optimum clearance with no user maintenance.

The lifters require greater oil flow and cleaner oil, and thus also require the spin-on-filter pump with larger gears than used on older engines. The full-flow filter keeps the oil clean to prevent fouling the lifters, and the larger gears provide more oil flow.

When properly bled and adjusted during assembly the lifters should not require re-adjustment until an engine re-build is needed.

Some owners report various problems with hydraulic lifters that can usually be traced to a couple of causes:

When adjusting the lifters, the clearance is first adjusted to zero clearance; and then an additional turn in to compress the piston in the lifter to allow them to self-adjust. This assumes that the “zero clearance” is when the valve train first contacts and the lifter piston is fully “solid” at maximum extension. If the lifter has bled down, and the “zero clearance” position is started with the lifter mechanism partly compressed, an additional turn may bottom out the lifter and keep the valve from seating fully. This can cause poor idling and valve burning.

Valve clatter can occur when one or more lifters bleed down and cause excess lash clearance before they again pump-up to proper operation. An owner may “panic” when he encounters lifter clatter, and re-adjust the valves while the lifter pistons are partly collapsed; thereby adjusting them too tightly and causing the problems noted above. There will be conditions that cause lifters to bleed down (see below), but this is a minor issue; so don’t be too aggressive to over-react. Just drive the car fully warm and the lifters should pump up within minutes to a few days. Driven sensibly there should not be damage from this condition.

Lifter clatter seems to be worse when too heavy oil is used. When a valve stays open with the engine off, the valve spring may hold enough pressure on a lifter to cause oil to seep out. With a thick oil the lifters don’t fill again as easily as with a thinner oil. That’s why you typically have to drive with a hot engine enough to get the lifters to quiet down, as the oil thins when engine gets warm. By using a wider-range oil that’s thinner when cold the lifters will pump up faster. Synthetic oils also thicken less when cold and are available in wider viscosity ranges. After changing our cars to 0w30 or 0w40 synthetics lifter clatter hardly ever occurs, and quiets quickly if it does. A 0w40 synthetic should be excellent for all climate conditions.

Owners also notice lifter clatter occurs more often if the engine is started and stopped without being allowed to warm up. (Wasserboxer owners also report this.) Avoid this when possible.

People familiar with exhaust valve stretching and failure on older VW engines may be concerned that this condition will not be detected with hydraulic lifters. However, the operation of the ACD as a system makes valve problems less likely than on older engines. Exhaust valves are largely cooled by heat transfer to the valve seat when closed. Hydraulic lifters maintain consistent valve operation, assuring the valves are in contact with the seats the proper cycle time to provide cooling. The Digifant closed-loop system keeps proper mixture to avoid overheating from a lean condition. Finally, the port injection helps cool the heads through fuel vaporization. Added up, the likelihood of valve problems is greatly reduced, and should not be a concern.

### **Engine Cooling and Warm-up**

Older VW engines were known to wear faster if thermostats and shutters were removed. The ACD engine does not come with either installed, and owners may be concerned about the effect on engine life. Although the decision not to use this system on the ACD certainly included cost concerns, there



also may be less need for them, and the effect on engine life should be minimal. Rapid engine wear during warm-up has several causes, which are minimized for the ACD today.

1. Rich running during warm-up is minimized by the Digifant system. On older engines with carburetor and choke, the mixture would be very rich with a cold engine, and fuel would condense on the cylinder walls washing off the oil film, causing rapid wear. The Digifant is less-rich on startup, and leans out rapidly to prevent this cause of wear.
2. "Classic" engine oils were so thick when cold that they could not flow through the oil passages well, and much would bypass directly to the sump, giving less flow to the wearing parts. Modern oil, such as 0w40 synthetic, flows so well at cold temperatures that oil pressure should stay low enough to keep the bypass relief closed, providing better flow to the wearing parts.
3. Modern synthetics also have better lubricating properties when cold, also causing less wear.

While the Mexican domestic climate may not see the extremes of other world areas, these system considerations probably had more influence on the decision to drop the thermostat than the climate.

Because these cars use the basic heat and ventilation system with defrost vents only in the corners of the windshield, defrost in the mornings in cold climates can be a challenge. It can be improved by fitting the thermostat and shutters used on the 70's engines. The fan shroud and engine tin still has the mounting points, and the shutters and linkage can be easily fitted. The engine case still has the cast boss where the thermostat bracket would be mounted, but it is not drilled or tapped for the mounting stud. This can be easily done by removing the lower tinwork and heat exchanger on the right side to gain access.

The mounting point for the linkage return spring is different than the older doghouse shroud, so the older spring would stretch too far and put too much tension on the mechanism. Either get the later Brazilian spring, or add an extension wire to the spring.

Adding the shutters will increase the defrost air flow when the engine is cold, as they reduce air flow to the engine, raising the shroud internal air pressure, causing more flow to the open heat exchanger path. Once the shutters open as the engine warms, the defrost flow is the same as without shutters, but the warmer air is effective.

The shutters may actually cause the oil to warm up slower than without them! With the doghouse shroud the shutters do not close off airflow to the oil cooler. So the higher shroud pressure with the flaps closed results in more cold air flow through the oil cooler. It is probably best for the engine to leave the heater controls for the passenger compartment fully on during engine warm-up.

In the 70s VW sold accessory covers to block some of the engine compartment inlet vents in cold weather, as the doghouse design does over-cool the oil in these conditions. This is obvious if either an oil temperature gauge or oil pressure gauge is added. Synthetic oils (0w30, 0w40, or 5w30, 5w40) should flow and lubricate better in these conditions, but the colder oil temperatures may still result in water condensation accumulating in the oil. More frequent oil changes are still a good idea in cold weather.

## Ignition System

There are several changes to the ignition system in these models:

1. A breakerless, non-advance distributor is used, similar to the one used on the 86-91 wasserboxer in the Vanagon.
2. Advance is controlled by the Digifant ECU.
3. The signal from the ECU triggers a square coil with an integral electronic module. (Also used on Golf / Jetta in the 1990s.)
4. The plug wires uses the newer-style electrical connector that grip a pin in the distributor cap rather than expand into a ring in the cap. (The older wires will not work properly, unless an older-style cap is also used.)
5. The spark plugs are now ¾-inch reach (longer threads) due to the thicker head walls. This should reduce cracking of the heads around the spark-plug and valve seats.

These changes mean that timing should not change due to normal wear, a stronger spark is produced, and less maintenance is required.

## Transmission

The transmission uses the swing-axle design of 1968, with the wider brake shoes, 4-bolt drums, and long-spline axles introduced that year. It also uses the “Z-bar” for suspension control. Although this sounds strange to the US enthusiast, where the swing axle disappeared after 1968, this style never actually went out of production for the rest of the world. The IRS rear suspension, however, did go out of production once the US stopped importing the Beetle.

The transmission uses the familiar 12-volt starter and smaller bushing, and – unlike older swing axle transmissions – adds the throw out bearing guide-tube around the input shaft common to 1971 and later Beetles. This means the later style throw out bearing must be used for replacements.

## Brakes

A dual-circuit master cylinder is used with front disk brakes of the same design used on US KG cars. (Other worlds areas used these brakes on Beetles in the 70s also, although they were not used on US Beetles.) This results in excellent brake feel and control, but with the light Beetle front end it is still easy to lock the front brakes first and lose steering control.

The front disks do not require periodic adjustment, but the rear drums do require adjustment just like the older Beetles.

The brake warning light is now an LED integrated into the gas gauge.

## Wheels and Tires

Because of the swing axle rear camber changes, the Mexican production kept using 155R15 tires throughout Beetle production, up until the Ultima Edicion special model that used a 165R15 whitewall tire. Many people think the narrower 155 tire wears better with the swing axle transmission. Both

General and Continental made tires in this for the Mexican market, but they are very hard to find in the US. The 165R15 tire may be the only feasible replacement.

There were some factory accessory aluminum wheels, styled similar to the New Beetle wheels, available in Mexico. However nearly all production used the familiar steel wheel. Most models came with a small center plastic cap for the axle end, and with plastic caps over the lug bolts. However, the wheel is made to fit the common steel hub caps used in earlier years.

## Chassis

The original chassis on these cars resembled a 1975 Fuel-Injected Beetle chassis, with the later style floor-pans and seat mounts, and dual fuel lines. The front transmission mount was the pre-73 style. Because of the swing axle rear suspension, no inner pivot brackets were used. However the frame horns were formed to fit them, with blanking plates welded in.

Of course, nearly all cars imported to the US were re-mounted on a 1973 or earlier chassis, modified as needed to fit the later parts. Thus a 69 or later chassis could easily be fitted with a later IRS suspension if desired. Most of the older chassis will have had new floor pans welded in to fit the new style seats, new fuel lines run to the rear, and possibly repair to the clutch tube through the chassis, etc.

[www.btlmex.com](http://www.btlmex.com) was selling the Mexican chassis removed from their conversion cars, and while these would likely not be legally usable for US registration, they could be a good source for chassis repair parts. The possible use as a chassis for replacement use would depend on the codes of the state having jurisdiction.

## Instruments

The only instrument is the familiar VW speedometer, with built-in indicating lights and fuel gauge. Like the rest of the world all speed and distances are in metric units. The housing for the speedometer is now plastic, with some differences from the old units. The gas gauge now incorporates a brake warning LED behind the speedometer faceplate, and the associated electronic circuitry. The “vibrator” voltage stabilizer for the gas gauge is no longer used.

If the owner wants to change to a speedometer with measurements in miles, the gas gauge and brake warning light will not simply fit into an older speedometer housing. However, the Speedometer mechanism of an older unit will fit directly in to the new housing, and then the new gas gauge assembly can be maintained. Only one small hole must be drilled in the old faceplate for the brake warning LED.



## Controls

Dash switches are now rectangular rocker switches as on other VW models. A dual-stalk turn signal and wiper control is used, but the windshield washer is now an electric pump unit, so the stalk no longer has a control valve for the pneumatic washer.

The heater control is still a lever to the side of the handbrake; but only one lever controlling the flaps on both heater boxes is provided. There are no rear-seat heat vents or defroster, and therefore no controls for them. Floor heating is by outlets under the doors, with operating levers on each grill. Close the floor vents to increase air to the defrost vents. There is no fresh-air ventilation system.



### Anti-theft devices

Both an alarm system and electronic immobilizer were standard for the last years of Beetle production. The alarm uses a mechanical key switch in the left front quarter panel, using a round key. It senses the door “light” switches, and similar switches mounted on the front hood and rear engine hatch. Opening any of them will cause a separate horn to sound, which is mounted in the engine compartment.

The immobilizer is a small relay box that switches power from the starter and ECU if an attempt is made to start the car without “keying” the immobilizer.

Most cars used a “key-fob” chip that had to be inserted into a socket in the center of the dash and then removed. The car could then be started within 30 seconds. An LED on the socket would flash when the immobilizer would not be reset to start the car.



There have been cases where the both relays in the immobilizer did not latch correctly, allowing the starter to work, but not the ECU, so the car would not run. Usually “keying” the circuit again would correct this.

Replacement keys to match the immobilizer are not available, but a complete replacement unit, with 2 keys, is available from [btlmex.com](http://btlmex.com).

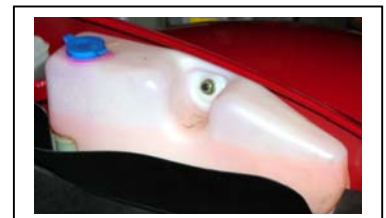
The immobilizer box itself is mounted in an inaccessible area. Most were under the rear seat by the ECU, protected by a heavy metal shield attached by shear-bolts to prevent tampering.

There is a way to bypass the immobilizer so the key-fob is not needed; but that will not be covered here for security reasons.

The Ultima Edicion and other 2004 cars used an RF wand that did not need the socket on the dash.

### Windshield Washer

A new electric pump washer tank is used that mounts to the left front quarter panel inside the trunk, and is formed to fit the Beetle side with minimal effect on the trunk. It mounts to one of the fender bolts, which is longer to allow a nut to hold the bottle in place.



## **Electrical System**

The familiar Bosch 51Amp alternator with internal voltage regulator is used on the engine. The standard battery supplied is a 36AH unit – much lower capacity than the 45 AH battery used in the 70s. The new systems put a small continuous drain on the battery, and many users report their cars will not start if unused for several weeks. Adding a modern radio also adds to the current draw, as most radios now include clock and active electronics that consume some power even when shut off. A standard group size 42 battery with higher capacity is a good replacement.

Headlights are now halogen with separate bulb.

Front turn signals are mounted in the front bumper. Replacement Hella units from several US suppliers fit correctly.

## **Bumpers**

The bumpers look like those on the 68-73 cars, except the black stripe along the middle of the bumper is wider, and the front bumper has cut-outs for the turn signals. However different mounting brackets are used, so the bumpers have slightly different mounting holes. The older bumpers will fit by either using the old brackets (which fit the body), or drilling holes to fit the new brackets.

Except for the Ultima Edicion the bumpers were typically painted the body color with the wide black stripe. Btlmex sells the chrome bumpers as used on the Ultima Edicion. These are probably the best quality chrome bumpers of this style available, with very good chrome plating. The steel used is about twice as thick as the common Brazilian aftermarket bumpers.

## **External Trim**

Door, hood, and trunk handles are painted black on most models, but can be easily changed to chrome versions. (Same design as used in the 70s cars.) If you change the handles the lock cylinders can be swapped to the new handles so the same keys will work.

## ACD Engine Diagnostics

The Digifant ECU communicates for adjustments and diagnostics. It is intended to use the VAG1552 or VAS5052 diagnostics tool used by VW dealerships. However, it does not use the now-standard 16 pin DLC connector as do US models, so it requires an adapter cable. Although VW models sold in the USA are “OBDII” compatible so some diagnostics can be done with standard OBDII scan-readers, the Sedan is NOT OBDII compatible as it is not intended for sale in the US.

The cost of the VW dealer “scan tools” makes them impractical for the normal owner-mechanic. One solution is the “VAG-COM” software and adapter cables from [www.Ross-Tech.com](http://www.Ross-Tech.com), which allows a laptop computer to duplicate the functions of the VAG1552. VAG-COM is available in both English and Spanish (also German) from the Ross-Tech website.

## Interface Adapters

Adapting the Sedan diagnostics connector to the VAG-COM can be done using two VW produced adapter cables. One adapter converts the 16-pin OBDII socket to the older VW 2x2 connectors, and the other converts the 2x2 to the special 3-pin diagnostic socket used by VW-Mexico on the Beetle harness. The 16-pin to 2x2 adapter typically costs about \$50, and the other cable is hard to find. However, since only 3 wires need to be connected, there are several approaches to adapt the car to a standard interface.

The Sedan diagnostics connector is located inside the engine compartment, normally “parked” on a dummy connector mounted in the top-left corner near the hinge for the cover:



To enable the car to be used only with standard 16-pin interfaces, a DLC connector could be spliced in place of the 3-pin socket. Because it is located in the engine compartment, it should be protected by a cap, and would require a custom bracket to mount the connector. If this method is used, gold plated contacts might be a good idea

If you have an interface that will only be used with the Beetle, it may be possible to replace the DLC connector of the interface with the 3-pin plug to fit the car. This would depend on the way the interface is made, as some have the connector on a removable cable (Ross-tech ISO-COM). However, many build the interface electronics into the connector. Use the shell and contacts listed below.

Most would probable prefer making an adapter cable to leave both the car and the interface un-altered. This requires a 3-pin connector shell (357 972 763), two double-ended contact pigtails (000 979 129)

(to get three contacts plus a spare), a 16-pin DLC connector shell (1H0 972 695), and two double ended contact pigtails (000 979 131) for it. Wire this per this pin-out:

<u>Car Connector</u>	<u>OBDII 16-pin connector</u>
Pin 1 Striped (K-line)	pin 7
Pin 2 Brown (Ground)	pin 4
Pin 3 Red (+12V)	pin 16

Cut off the mounting ears from the DLC shell (for dash mounting), and shrink 2 layers of 1 1/2" heat-shrink tubing over the back as shown to serve as a handle.



### General Procedures

VAG-COM can be run on a small tablet PC, which makes a very portable and handy diagnostics system:



After connecting the cable and starting the laptop and VAG-COM software, turn on the ignition and select the Engine Controller. (VAG-COM also supports a lot of other controllers used on other VW-Audi vehicles, but only the Engine Controller is used on the Sedan.) The laptop attempts to communicate with the car, and after a minute of trying different protocols it will display the following controller info:



This information will vary slightly depending on the year vehicle. This is from a 2001 model year. The 2000 models used the 043 906 022 D version, which is nearly identical in function. The earlier years



may go back to 043 906 022 B that is Digifant 1.80, apparently with fewer features supported for diagnostics.

## Fault Codes

These Digifant versions do support “DTC” storage or “Diagnostic Trouble Codes” like OBDII cars. When the controller or ECU notices a sensor reading outside the range it expects it will log an error code that identifies the problem. With VAG-COM you just click on the “Fault Codes” button and it displays all the stored DTCs. Here is an example caused by a loose O2 sensor cable:



In this case VAG-COM shows both the basic code (00525) and the “additional information” code 03-10 that it is an intermittent fault.

After recording the codes (click “Copy Codes” and paste to a Word document) you can erase the codes by clicking the “Clear Codes” button, to see if they reappear, which would mean the problem still exists. Some codes will only reappear after driving for an extended time, or for more than one driving cycle. The following table should be helpful in finding causes of the errors that may be reported.

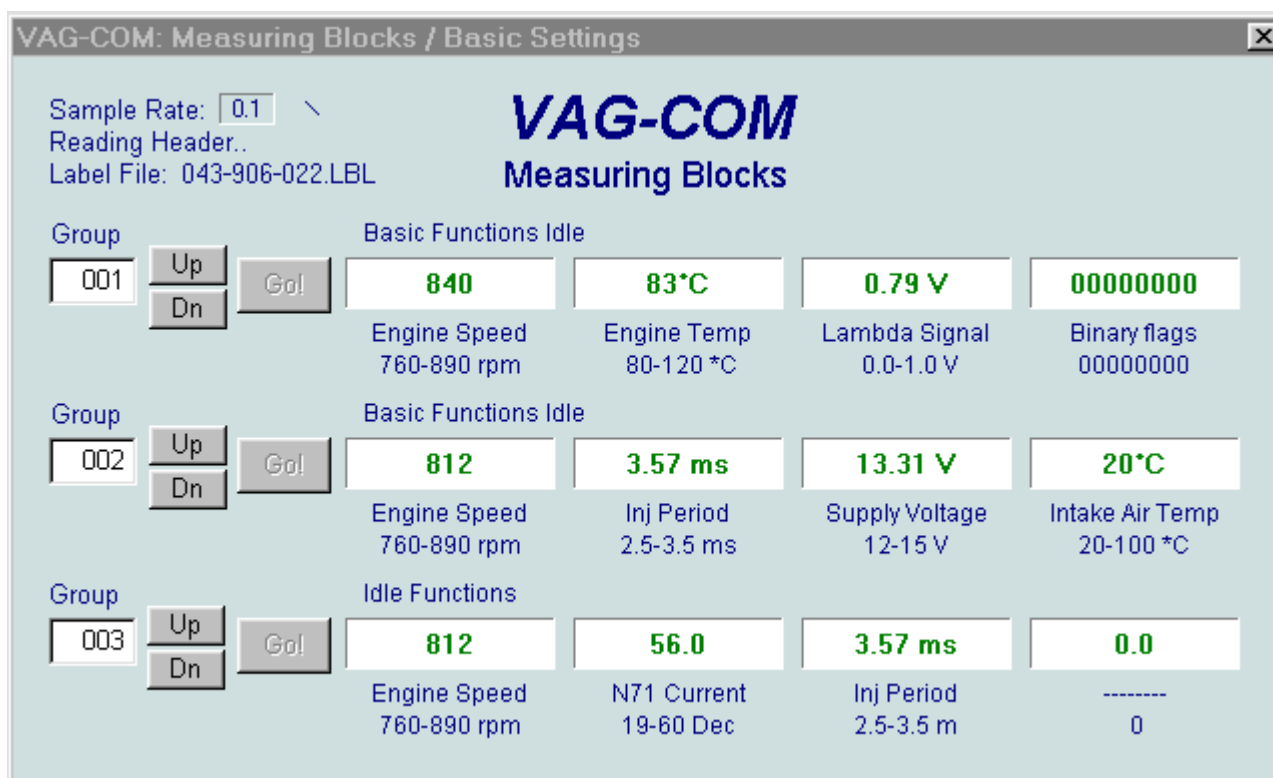
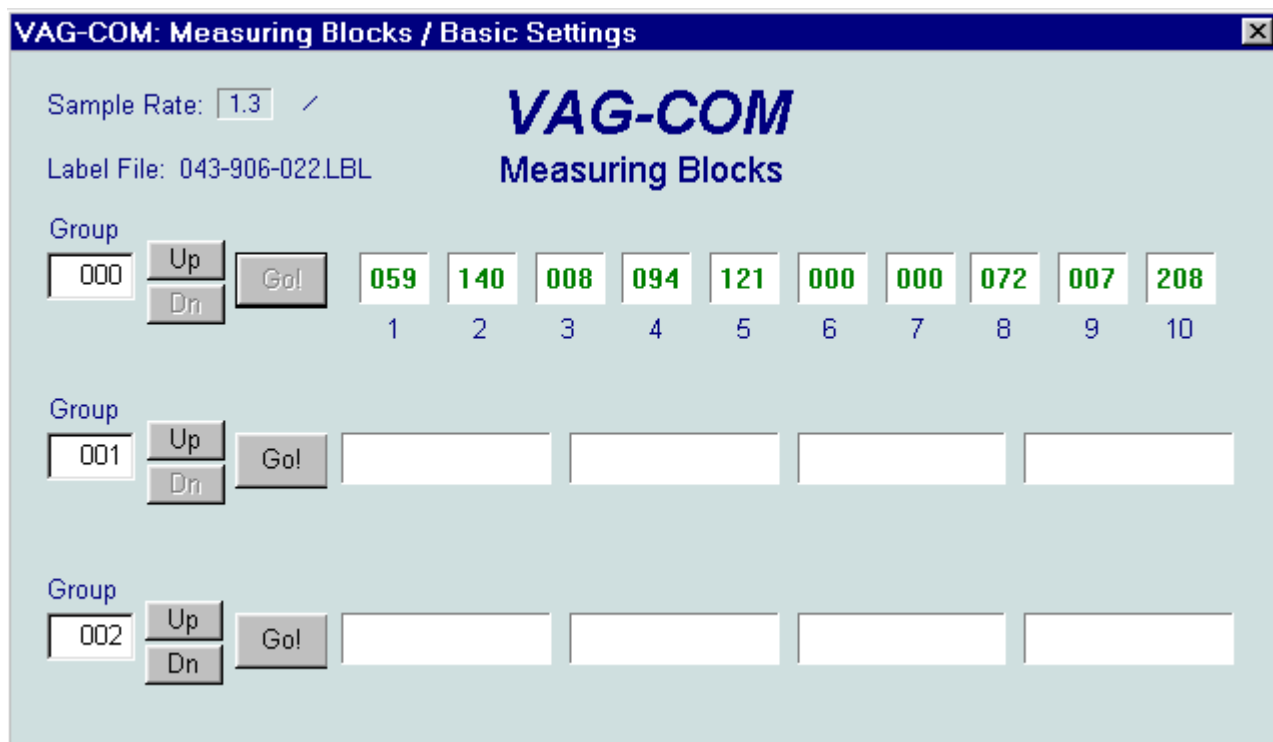
**Diagnostic Trouble Codes supported by 043 906 022 E Digifant control unit:**

DTC	Message	Possible causes
00515	Hall Sender G40, Open circuit or short circuit	Wiring or defective part
00518	Throttle Valve Position Pot G88, Open circuit or short circuit	Wiring or defective part
00519	Intake Manifold Pressure Sensor G71 - no signal	Defective sensor, tubing to manifold
00522	Engine Temperature Sensor G27, Open circuit or short circuit	Defective part or corroded contacts
00523	Intake Temperature Sender G42	Wiring or defective part
00525	Lambda probe G39, No signal	Wiring or defective part
00532	Supply Voltage out of range	Should be 10 to 16 V
00533	Idle speed control too high/low	Valve N71; connector; air leaks
00537	Lambda regulation out of range	Probe heating; Exhaust leak; Ignition fault; Intake leak; injector fault; Evap valve open; high fuel pressure
00561	Fuel Mixture adaptation out of range	Fuel Pressure, Ignition problem, Intake leak, Injector fault, Exhaust leak, Evap valve open
0069	Ignition output short	Check N571 transformer
01247	Evap Valve N80 open or short circuit	Wiring or defective part
01257	Idle Speed Stabilization Valve N71, short or open circuit	Wiring or defective part
01259	Fuel Pump relay J17, short to positive	Wiring
65535	Control Unit Defective	Replace ECU J169

### Measuring Blocks

Besides simply reading and clearing DTCs, the VAG-COM software lets you watch engine and sensor readings while the engine is running, using the Measuring Block functions like the VAG1552. This can be very useful for troubleshooting, to compare actual readings to the expected range of values. Also, by recording the readings while your engine is running properly you have a starting point to look for changes when trouble occurs. It is a good idea to take “snapshots” of the measuring block values on your properly running engine for comparison later.

VAG-COM lets you display more than one block at a time, but as you display more than one measuring group the sample rate decreases. You get fastest readings by displaying a single block.



VAG-COM: Measuring Blocks / Basic Settings

Sample Rate: 0.1 \

Reading Header..

Label File: 043-906-022.LBL

## VAG-COM Measuring Blocks

Group 004 Basic Load Idle

Up	Go!	812	35.5%	255.0	01000000
Dn		Engine Speed 760-890 rpm	Eng Load 22-35 %	----- 255	----- 00000000

Group 005 Vent Functions Idle

Up	Go!	812	0.0%	3.0	217.0
Dn		Engine Speed 760-890 rpm	N80 Current 0 %	----- 0	Atm Pressure 174-250

Group 006 Idle Functions

Up	Go!	96.0	130.0	53.0	72.0
Dn		Engine load 50-100 Dec	Lambda Learn 80-140 Dec	N71 Current 19-60 Dec	Throttle 11-103 Dec

VAG-COM: Measuring Blocks / Basic Settings

Sample Rate: 1.7 -

Label File: 043-906-022.LBL

## VAG-COM Measuring Blocks

Group 008 Idle Functions

Up	Go!	812	0.0	0.0	53.0
Dn		Engine Speed 760-890 rpm	----- 0	----- 0	N71 Current 16-80 Dec

The default VAG-COM labels for the readings are generally good, but a custom label file (043-906-022.lbl – used in the above screens) gives more detail.

## Measuring Block table

The specified data is in the following table. Note that specified ranges are all when recorded with the engine idling after full warmup.

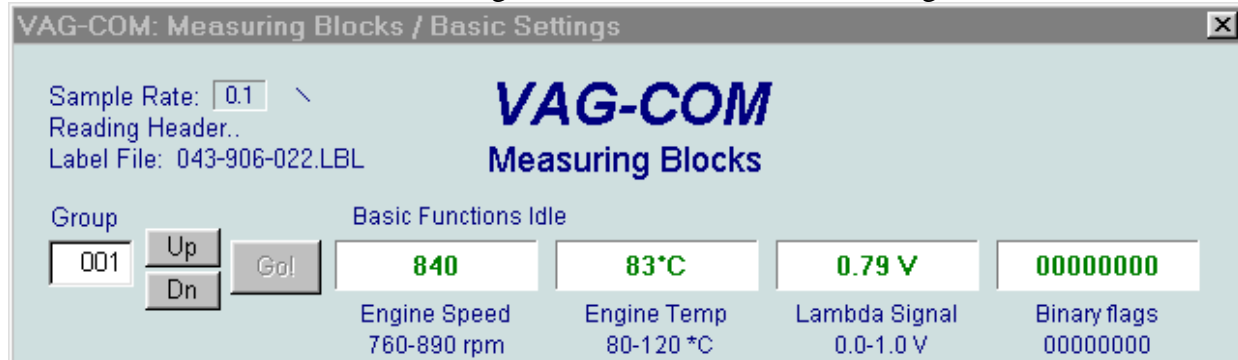
Group	Zone 1	Zone 2	Zone 3	Zone 4
1 - Basic Functions	Engine Speed, idle 760-890	Engine Temperature, 80-120 C	O2 signal in Volts 0.0-1.0V	Digital Code 8-bit (all 0 for Basic Setting)
2 - Basic Functions	Engine Speed, idle 760-890	Injection period, 2.5-3.5ms at idle	Supply Voltage, 12.0-15.0V	Intake air temperature 20-100 C
3 - Basic (default) Functions	Engine Speed, idle 760-890	Current to idle control valve; 19-60 at idle	Injection period, 2.5-3.5ms at idle	-----
4 - Basic Functions	Engine Speed, idle 760-890	Engine Load, 22.0-35% at idle	----- (255)	----- (00000000)
5 - Basic (default) Functions	Engine Speed, idle 760-890	Current to N80 evap valve, 0% at idle	----- (0)	Ambient Pressure digital (250 sea level)
6 - Basic (default) Functions	Engine Load, decimal 50-100 at idle	O2 learning value decimal 80-140	Current to idle control valve; 19-60 at idle	Throttle Position, digital 11-103
8 - Basic (default) Functions	Engine Speed, idle 760-890	----- (0)	----- (0)	Current to idle control valve; 19-60 at idle

## Performing Basic Setting

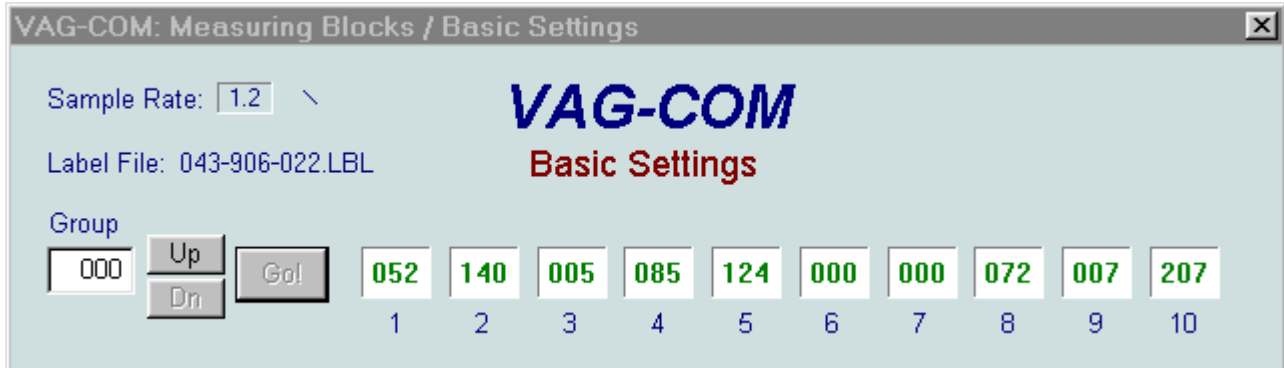
The ECU is matched (adapted) to the throttle body and engine sensors by using VAG-COM to initiate the Basic Setting mode. This procedure is only valid providing all engine sensors are operating properly, and the following conditions are met:

1. Ignition timing checks 6 deg +/- 1 deg
2. Engine running at idle speed (throttle fully closed, under 2150 rpm)
3. Engine at normal operating temperature (more than 80 deg C)
4. No DTCs (fault codes) stored in ECU memory
5. All electrical consuming accessories turned off.

When these conditions are met, the digital values in field 4 of measuring block 1 will all read "0":



Once these conditions are met, display measuring block 000, which is where Basic Setting should be initiated:



The display “zones” relate to:

Zone	Variable
1	Intake Air Temperature
2	Battery Voltage
3	Engine Temperature
4	Load (vacuum sensor)
5	Lambda probe signal
6	(Vacant)
7	(Vacant)
8	Throttle Valve Potentiometer
9	Injection Period
10	Engine Speed

The values are not in engineering units, but are simply the digital values read on each channel.

Before entering Basic Settings these values should be seen:

Display zone 3 (Engine Temperature) below 044

Display zone 8 (Throttle Valve Position) above 008 and less than 113

Display zone 10 (engine Speed) above 128

If so, click on “Switch to Basic Settings”

If the timing checks OK (see Ignition Timing below), wait for at least 60 seconds in basic settings mode for the system to learn and save the adaptation figures. Values include:

Ignition timing 5-7 deg btdc @ 1500

Idle speed 800-860 rpm

CO content (pre-CAT) 5.5-8.5 %

Lambda signal (zone 5) 100-250 fluctuating

Load (manifold pressure zone 4) 50-100

HC value <300/1000

After at least 60 seconds has elapsed, the ECU learns and stores the settings. Then exit Basic Settings mode, and check the fault memory to assure no faults were reported.

## Ignition Timing

Ignition timing is checked by aligning the TDC crankshaft pulley mark with the engine case “split” line using a digital advance timing light to measure the advance. Unlike older Beetles there is no mark on the pulley at the correct advance, although one could be added at 6 degrees BTDC.

In normal operation the Digifant ECU controls the ignition timing, so an attempt to check timing at normal idle will not give the expected result. In fact the retard at normal idle is to approximately 0 TDC. This means a rough check with a timing light will show the TDC mark about at the case split. (This is not a very accurate check, but can be an easy start to look for problems.)

When you initiate Basic Setting mode the Digifant ignition control is disabled, and the idle is controlled to 830 rpm, so the timing can then be checked by a digital advance timing light to see if the TDC pulley mark lines up with the case split. The checking tolerance is 4-8 degrees BTDC at 830 +/- 30 rpm.

The available tech information does not give a step-by-step procedure, but notes that the vacuum signal line from the manifold to the ECU should be disconnected when checking / setting timing. The specified setting tolerance is 5-7 degrees BTDC at 1500 rpm with a fully warm engine; however the method for obtaining the conditions to set the timing this way were not specified in the information I have found. In normal operation the Digifant system controls advance dynamically. Timing cannot be adjusted in the normal Basic Setting mode as it controls the engine speed down to 830. It is possible that the timing could be set by carefully holding the RPMs at 1500 in normal mode, but this is touchy. If anyone has further information about out to obtain the setting conditions please let me know.

Some VW ECU systems that require a timing adjustment, like the MP9.0 system (also not sold in the US), will control the engine to the correct conditions when Basic Setting is initiated with a certain measuring block displayed, but I have not yet discovered such a function in this Digifant system

With lack of the correct procedures to get the timing at 1500, it appears close timing could be obtained by setting the timing mark (TDC) at the case split at normal idle; and check at 6 BTDC as basic setting mode is started.

At the least it would be a good idea to check the setting on a car and record the results, so it could be duplicated if a distributor needs to be replaced.



## Other Operation Problems

Symptom	Possible Fault	Possible Solutions
Low performance, surging	Incorrect mixture; manifold pressure sensing	Basic Setting, vacuum lines, ECU
High Idle Speed	Adaptation off, manifold pressure sensing	Basic Setting, vacuum lines, ECU
Irregular Idle Speed	Engine Temperature sensor, adaptation, OXS voltage low	Replace CHT, Basic Setting, Replace OXS
High Fuel Consumption	Odometer error, sensor or OXS short or error; adaptation	Check odometer, check diagnostics codes; check sparkplugs, perform Basic Setting
Engine does not start	Immobilizer fault, fuel or ignition fault	Reset immobilizer; Operate Starter 10 sec, check DTCs. Check fuel pressure, check spark

The immobilizer is a separate box with latching relays that shuts off current to the ECU and starter if an attempt is made to start the car without keying the immobilizer. Because two relays are involved, it is possible for one to latch and not the other, so the starter may work but the engine will not run. Usually resetting the immobilizer again will cure this.

US Beetles are notorious for having a plastic gear in the odometer crack and slip, causing the indicated distance traveled to read low. If fuel consumption appears to increase, always check the odometer reading over a distance to be sure this isn't the problem.

If fuel consumption does increase, check sparkplugs for indication of a rich condition (sooty deposits). The ACD plugs normally stay light grey to white, and if they maintain normal color the mixture is probably OK, and another cause (rubbing brakes, tires or pressure) may be indicated. Mileage can also vary a LOT depending on driving style. (Has your son been driving the car?)

A common complaint is that the idle speed will stay too high when coming to a stop, until it is pulled down by letting the clutch drag. This is probably partly due to tightening emission controls, as "backing-down" or engine braking can increase emissions if the throttle is closed. Earlier ECUs (B version) seem to drop the idle faster. Careful "basic setting" does seem to help this condition.