VW Automatic transmission: Presentation, working and enhancements

1- Driving with a BVA

Translator's note: BVA is the French abbreviation of Boite Vitesse Automatique and is profusely used in this text. It can be translated as Automatic Gear Box. We decided to leave it as is in this text

The first visible difference to the driver is no Clutch pedal and replacement of the gear shift lever by a marked line selector cabalistic signs (PRND321). Letters that are also found on a display on the dashboard.

Another difference, audible this one, is the frequent printing of "skating-slipping" because the engine speed is not proportional to that of the wheels. This difference is due to the converter slip.

Selector's positions

- P: Parking mode, which must be used for parking. Wait a complete stop before engaging this position (risk of breakage of the index).
- R: reverse (rear).
- N: neutral (neutral). A use in case of prolonged engine stop rotating. D: forward (drive). The Transmission Control Module or TCM takes care to choose the right gear.
- 3, 2 limits the last report to the selected numeral. Useful in the mountains for example.
- 1: first imposed speed, with starting torque and improved slowdown. Rarely useful except to operate at full load and on severe slops.

Start-up

In essence, the BVA is a source of danger. The vehicle can advance without driver intervention. They're stories (actually very old stories!) of passengers who inadvertently went into reverse in the absence of the driver, with the consequences that we can imagine! This is why we find loads of safety features on the BVA to avoid this kind of tragedy:

- One cannot turn the ignition key or operating the starter, if the selector is in the P (parking). This security is provided by a steel cable connected to a specific Neiman cylinder.
- Unable to leave the position P or N, without pressing the brake pedal. This time it's an electromagnet placed at the foot of the selector plays this role.
- This ensures that the driver is at the wheel!
- To reach a new position of the switch, the driver must also activate (or otherwise release) the nob located on the left side of the selector.

These securities are highly reliable, and failures rarely occur.

Driving with a BVA

Newbie mistakes

From the first meters traveled, a hardened manual transmissions driver will want to and look for the clutch pedal when shifting into a new gear. Instead of disengaging, the left foot meets the brake ... and it's a sudden stop!

- Once in the car, wedge (comfortably) left foot so as to prevent it’s access to the pedals. Personally after a long period without touching the BVA, I blocks it under my seat.
- The seat belts is not really an option!
- Do a test drive on a deserted road and make sure when leaving the parking lot, no vehicle tailgate’s you, otherwise, I don’t guaranty his front bumper!
- If you test the BVA for the first time, an ABS systems can procure a sense of security in case of sudden braking (eg in the roundabout!).

When in motion

They’re no "snow" or "sport" modes on the selector or on the steering wheel.
Instead, the "intelligent" computer (Transmission Control Module) interprets the instructions of the driver to deduce if it is rather like "sport" or "eco".

He takes him up to 20 km adapt to driving style and road conditions (load, slope ...), which can be fun (or annoying) when confronted with a succession of different conductors!

If this system disturbs you, it is possible to impose to 01P BVA models a single operating mode via VAGCOM.

Correction : Some petrol models have a dashboard mounted "sport" mode.

Kick down

To overtake, it is sometimes necessary to downshift. No need to manually shift the selector: simply press down on the accelerator, which triggers the kick down mode: the Transmission Control Module or TCM passes the lower gear and remains there as long as necessary. If the driver releases the pedal, a sign that he does not need this reserve power, the TCM returns to the higher ratio.

Slow-down and braking

The behavior of T4 depends on the torque converter locking or not: if it is active, there is engine braking. Otherwise - particularly at low speeds where the bypass is impossible - the engine can not brake the vehicle: it is as if he suddenly went into neutral. To compensate, you have to brake more.

To counter this problem, the braking components (discs, brake booster) are therefore oversized with BVA. The change of discs and pads may be more frequent than with a manual gearbox, similar to driving profile. But it is cheaper to replace brake discs than a clutch or a complete transmission!

Stationary position

On most of modern BVA's, in automatic mode D (drive), the idle speed is slightly increased for easy low-speed maneuvering. When stopped, the vehicle behaves as with a manual transmission during a hill start, "ready to serge ". To reduce noise and fuel consumption it is necessary to board the selector N or P during prolonged stops.

With some versions of the AG4, after a prolonged pressure on the brake pedal, the computer returns the box N and the engine idling, thereby reducing the fuel consumption and increases passenger comfort by suppressing vibration.

On the other hand, when starting on a steep hill, sometimes it's recommended to use the hand brake, the time the box sifts from N to D and the torque converter "recharges" with oil.

Parking

It is possible to shut down the engine in any BVA position, but the removal of the key is possible only if the selector is on P. Putting the selector in parking position should become a reflex. As a bonus, it usually provides to operate the handbrake.

NB: the parking pin is only active when it encounters a locking hole in the gear wheel (see below). The vehicle can move even a few centimeters after the release of the brake pedal, until engagement of the lug. If absolutely no movement is possible (eg stop at 5 cm from the wall), the vehicle must be immobilized with the handbrake.

Differential lock (or not!)

On T4 (Eurovans) with ABS braking, the computer typically includes EDL option for Electronic Differential Lock. In case of a skid at very low speed, or when one of the two wheels remains stationary, the computer brakes the spinning wheel to distribute the torque to the two front wheels.

It doesn't replace a true differential lock, much less a syncro mode (absent from the catalog BVA alas), but it can make a the difference on the small muddy roads...

To find out if your T4 has this option, see the label options generally placed under/near the fuse box.

- 1AH: EDL only (rare)
- 1AD: ABS + EDL
- 1AJ: ABS + ASR + EDL

Limp mode (safe mode)

The Transmission Control Module or TCM constantly monitors the operation of the BVA, including oil overheating and clutch slipping. If it finds serious inconsistencies, it cut out every thing and falls in Limp Mode (safe mode), cutting off all the valves. The display no longer indicates the switch position, the letters and numbers appear simultaneously (PRND321).

By default, the BVA locks the "hydraulic mode", in third gear, which allows you to get to (sometimes painfully) to the next parking stall ... or even the dealership if you're up to it!

Rear drive is available, but then again you have to rev up in order to move.

This mode is of course functional only if the corresponding clutches and brakes are still operational. In case of severe oil loss, rear drive becomes simply impossible (personal experience).

I actually experienced this great moment of solitude twice in my life:

A *hot day: while I driving quietly at 110 km / h, my BVA suddenly downshifted in 3rd gear. That a surprises! After a few minutes of engine shutdown, everything is back to normal after engine start. But I understood that my BVA had a severe overheating problem which I decided to fix.*

After having rebuilt the BVA, I noticed that I had forgotten to reconnect a speed sensor. While in Park mode, the dashboard gear position was behaving correctly but after driven just a few meters the computer sensed a fault and locked itself in third gear (limp mode) throughout the trip. This time the computer program required a complete faults code clearing using VAGCOM (1) to leave the Limp mode. As what it is able to tell the difference between a minor fault (occasional overheating) and major (HS sensor).

Basic settings

The behavior of the BVA's TCM is becoming erratic? Before bringing your BVA at the dealership for a complete review, try to return it to its original settings.
(do a hard reboot)

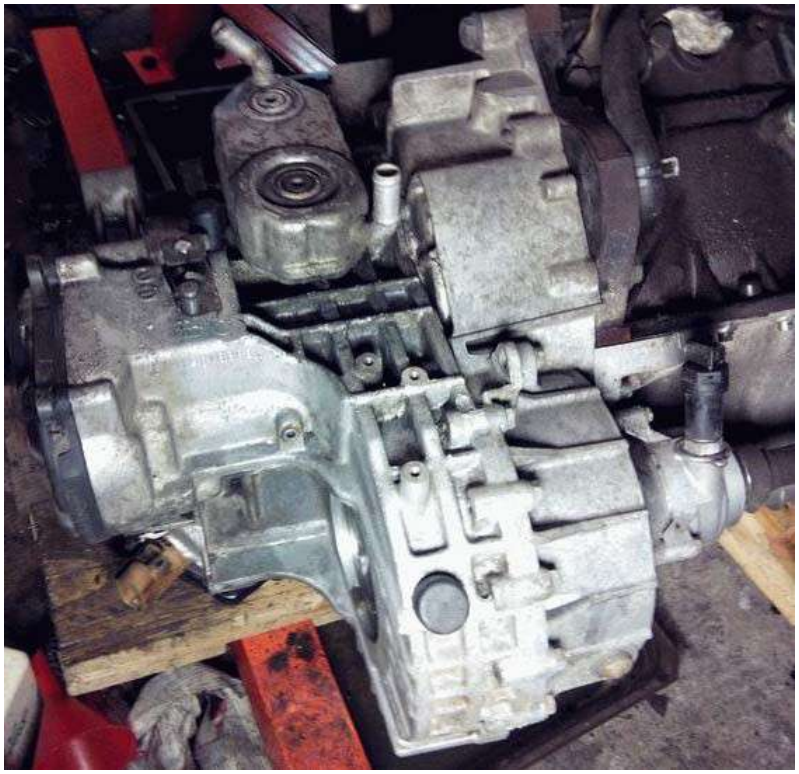
1. Put the car's contact ON, the stick shift in (lever "P"), without starting it.
2. Shift the stick shift to "D" (actuate the brake pedal to unlock the selector)
3. Fully press down the gas pedal and hold it down for 30 seconds. Ensure that the floor mats do not interfere with the operation.
4. After 30 seconds, return the switch to "P".
5. Release the accelerator pedal.
6. Cut contact.

Then do a road test, performing at least 3 upward gearshifts and 3 downshifts (kickdown), in different engine revving modes: moderate, medium, high. The BVA's computer will gradually adapt itself to the specifics of your driving.

Note: The computer usually takes from 80 to 120 km to "remember" its parameters, depending on the condition of the box (wear) and the type of driving.

[1] Translator's note: VCDS (an abbreviation for "VAG-COM Diagnostic System") and formerly known as VAG-COM is a Microsoft Windows-based software package, developed and produced by Ross-Tech, LLC since May 2000. It is primarily used for diagnostics and adjustments for Volkswagen Group motor vehicles, including Volkswagen Passenger Cars and Volkswagen Commercial Vehicles. The name "VAG-COM" derives from the acronym for Volkswagen Auto Group (VAG), the former name of the Volkswagen Group.

2- Introduction the VW AG4 automatic transmission



Cousin of Renault AD4, the AG4 automatic transmission, which has equipped many models of the VAG group (including the Transporter) until 2003 is a French design!
The AD4 box was designed by the STA ("Société de Transmission Automatique"), whose factory are located in Ruitz, in the Pas-de-Calais.

While Renault has outsourced the manufacturing of its AD4 which they had designed, VAG chose to concentrate the production of AG4 in its factories in Germany ... and also in Mexico, in order to meet the strong US market demand for this BVA which equips the US T4. The Transporter T4 is called Eurovan in the States and is mainly equipped with gasoline engines (particularly VR6).

Different versions

The T4 AG4 comes in 2 versions: 098 for "Phase 1" and later the 01P.
This coincides with the development of the T4 and Sharan TDI. Note that the TDI 151hp doesn't come equipped with the BVA option, only manual. On the other hand, VR6 204hp comes with a BVA as standard. With this combination, it's not the power (hp) which poses the problem, but it's torque at low rpm, which is very high on the TDI! We will come back to this later on...

The 098 version is "reinforced" model of the 095/096 series which was used on the wide range of VAG products in the late 1980s.

It's the same for the 01P model, which is a variation of the weaker 01M that appeared from 1995.

For the record, there is also an alternative version for the in-line engine: the 097 which became the 01N with the output shafts (power train) tilted at 90 °.

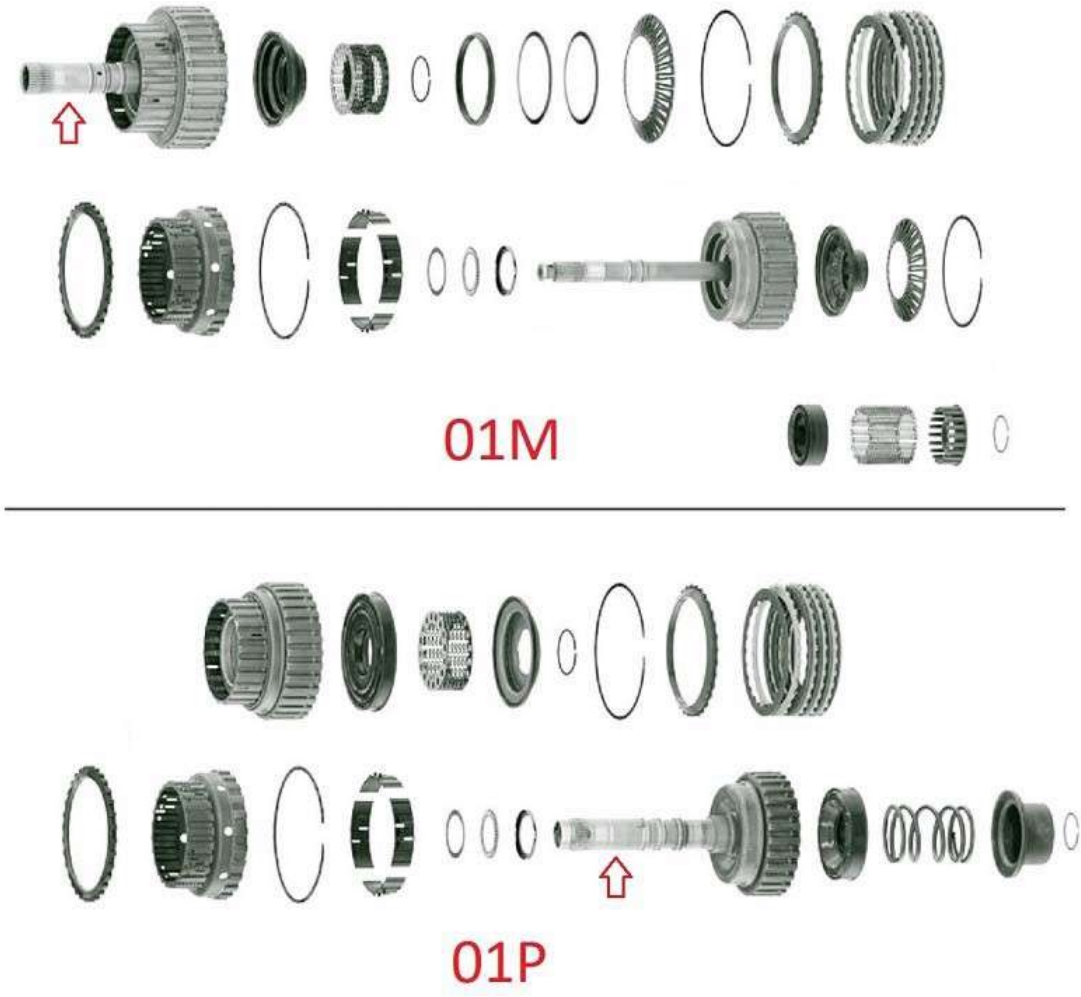
Now you should know you navigate through the maze of various versions (095/096/097/098/01M/01N/01P), and why when you study the various catalog you're left with so many parts references!

Specials aspects

Even if tutorials and basic documentation abound in English for the 095/01M, it is very difficult to find anything on the 098 / 01P versions.

After having watched numerous tutorial video, I realized that my box had to many similarities ... but also serious differences between models!

Here is a partial exploded view illustrating the difference between 01M and 01P.



The main difference is that the 095 / 01M features two concentric axes, as of the 098 / 01P contains only one. The shape or the thickness of certain parts also varies: trays, springs ...

Of the two concentric 01M axes protruding to the converter, the 01P is design obviously different.

The AG4 has variations depending on the vintage, as the type of hydraulic unit, the converter, the number of friction plates by clutch ... Each of these changes corresponds to a different computer.

The one presented in this tutorial is a 01P, model 1999, final drive "long", DXS mark. For more information on the various T4 BVA, transmission codes should be consulted.

Differences between the 098 and 01P

Enhancements

Here is a non-exhaustive list of changes made to the 01P compared to the 098:

- No more oil dipstick: the oil level is done with the VAGCOM. In practice it is rather a regression, which deresponsibilises the driver.
- Digital link with the engine control unit (eg TDI VR6 ...), except of course on models that lack (eg 2.4D)
- Increased the number of discs and plates, stiffeners ... One improvement that wasn't enough alas!
- New hydraulic fluid, more enduring in temperature ... but also more expensive!

Weaker points

Based on rumors, the AG4 would have been initially developed to equip the New Beetle for its US release. VAG later adapted the model to equip the European T4, but a little too hastily, it seems ...

T4 equipped BVA suffer from a bad reputation, so prices dip at purchase.

Is this bad reputation justified?

Unfortunately, yes. But we can - partially! Remediate it.

Lack of maintenance

Regardless of the German's VAG group recommendations, VAG France marketed the BVA as "oiled for life". Consequence: for lack of having done the required oil change at every 60,000 km, many AG4 on VW and Audi models had to be replaced with rebuilt ones starting from ... 80,000 kilometers!

Cost to the customer: about 5,000 €. A straw ![2]

This recommendation is know known by all transmission specialists and most T4 BVA owners.

Unfortunately, many trannies have suffered from more or less regular oil changes and for some BVA, the damage has been done, compromised the transmission's life span ...

Therefore caution is warranted when buying! Do not hesitate to interrogate the transmission's computer with the VAGCOM program to detect any possible defects.

Overheating

The temperature of the oil is a very important parameter for the survival of the BVA. The original cooling device is too small for T4, causing accelerated wear of the entire box : Converters, valve block, bearings, friction elements ...

[2] Translator's note: A straw!, a polite slangish French word which could be substituted with: Holy Shit!!

Locking torque converter problems

The locking torque converter reduces engine RPM at a steady speed, giving greater driving pleasure and reducing the fuel consumption important gap previously noticeable between manual and automatic gearbox. Unfortunately the clutch performing this function is largely undersized. Worse, on diesel models and especially the TDI, it has a tendency to stall at low speeds, causing destructive jerking moves that are detrimental to the entire box.

Wear

The clutches contained in the BVA may have very thin abrasive layer (less 1 mm), but they wear out very slowly.

A well driven, well maintained BVA can hold 300,000 km without worry….Tr Note: I'm flabbergasted

Unlike traditional clutches, these discs are immersed in oil. Even before these discs come into contact with the plates, the oil viscosity already procures a "hooking" or gripping, preventing frictional heat….only oil heat increase. Consequently, discs abrasion is minimal and therefore the very low wear.

Nevertheless, disk dust is formed inevitably. It is drained by the ATF (Automatic Transmission Fluid) and accumulates in the oil filter during oil recirculation. Hence the importance of changing it at every oil change, to avoid clogging ...

Friction also rips small metal shavings off the steel plates. These are captured by a magnet placed in an oil pan. What prevents them from returning to the circuit where they could do damage! Large amount of metal adhered to the magnet indicates either worn-out inner plates or end of life transmission or insufficient oil change!

Overheat remediation

In addition of respecting the oil change schedule, it is recommended to make these further modifications so as to extend the BVA life expectancy.

1- Ventilation housing

Cooling of the BVA may improve by using the same techniques used by VW Syncro: Air vent opening in the lower bumper section and cutting an opening in the underbody steel pan.

See this tutorial: Wiki@T4zone.info: Air flow bumper opening: Installation

2- New Oil Cooler

Replacing the original oil/water exchanger with a beefier one.

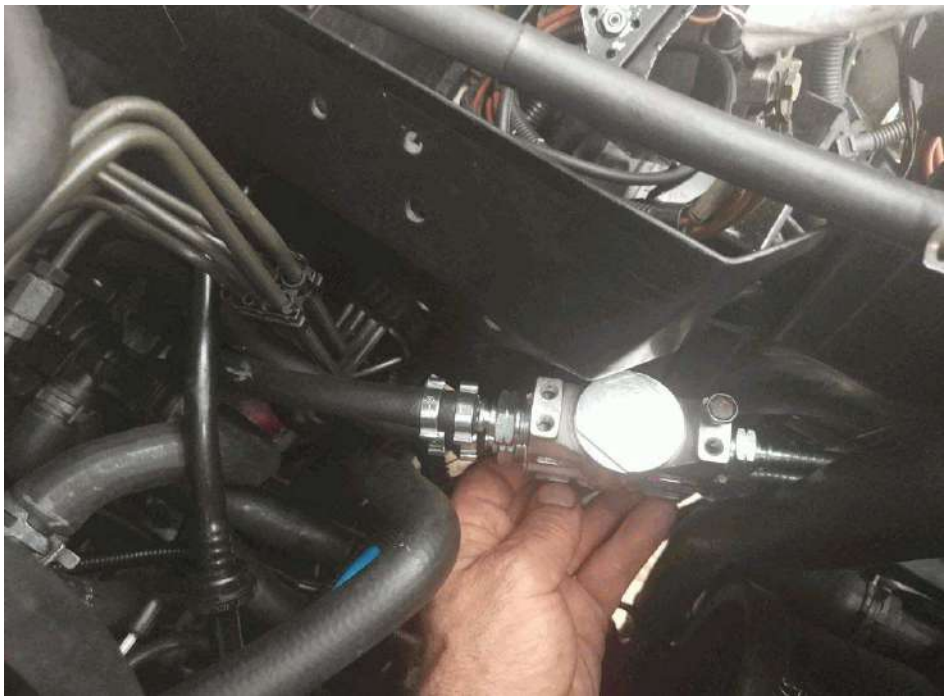
Binding to BVA is via a set of suitable connections (12x1.5) and high-pressure hoses (25 bar).

The installer should always be aware of any Galvanic Corrosion caused by dissimilar metal contact. Rubber or neoprene pads should looked into.


They’re a host of specialty retailers in the US that offer this kind of radiator… not very expensive. The main difficulty is to insert it behind the grill, especially if your T4 is a short nose which already has an air conditioning condenser!

Even with a low-profile model, one may have to slightly adjust the inside grille to accommodate the radiator, but it is not insurmountable, with a little care.

3- Thermostat installation



The radiator works so well that the oil is likely to remain at a temperature lower than what's recommended. For me (intentionally oversized radiator) on the highway at 130 km/h ATF remained at 70°C (158F) with 30°C ambient temperature. (86F)

A thermostat allows fastest temperature rise and maintain its optimum operating level regardless of the external conditions. Useful for highly stressed vans – such as heavy California.

4- Combining cooling water and air

An attractive alternative is to maintain the original oil exchanger, but to connect it to a three-way valve that diverts the fluid to a water radiator in front of the type used for the water-cooled motorcycle.
(Tutorial might follow)

This method allows to heat up the BVA's oil along with the engine. Very useful in winter, especially if the engine is equipped with a programmable auxiliary heater.

However the installation is complex, combining temperature sensors, valves and electric pump. For my part, I've never seen such a convoluted system on a T4.

Correcting the BVA's defects

1-Reconditioning

It isn't absolutely necessarily to take out the BVA to do a complete rebuild. It can be done with the tranny still in place.

The first step is to interrogate the computer BVA with VAGCOM. It will produce a diagnostic picture and recommend the needed solutions.

The hydraulic distributor (DH) is accessible from below without complete removal of the transmission. Diagnosing this unit can be done quite easily by an amateur, with a minimum of care.

If only the torque converter is deficient, provide for It's replacement, probably damaged.
In this case, the replacement requires the complete removal... but not opening it.
Numerous shops specialized in this expertise exists, especially in Germany.

Complete refurbishment or standard exchange of the converter are fast. Indication in 2017 that exchange cost 320 €, including labor and require less than a week delay, (TC-trading, Berlin).

Complete refurbishment of the BVA, start about 2000 € in Germany (excluding deposit-based BVA). This budget increases by ~ 50% in France

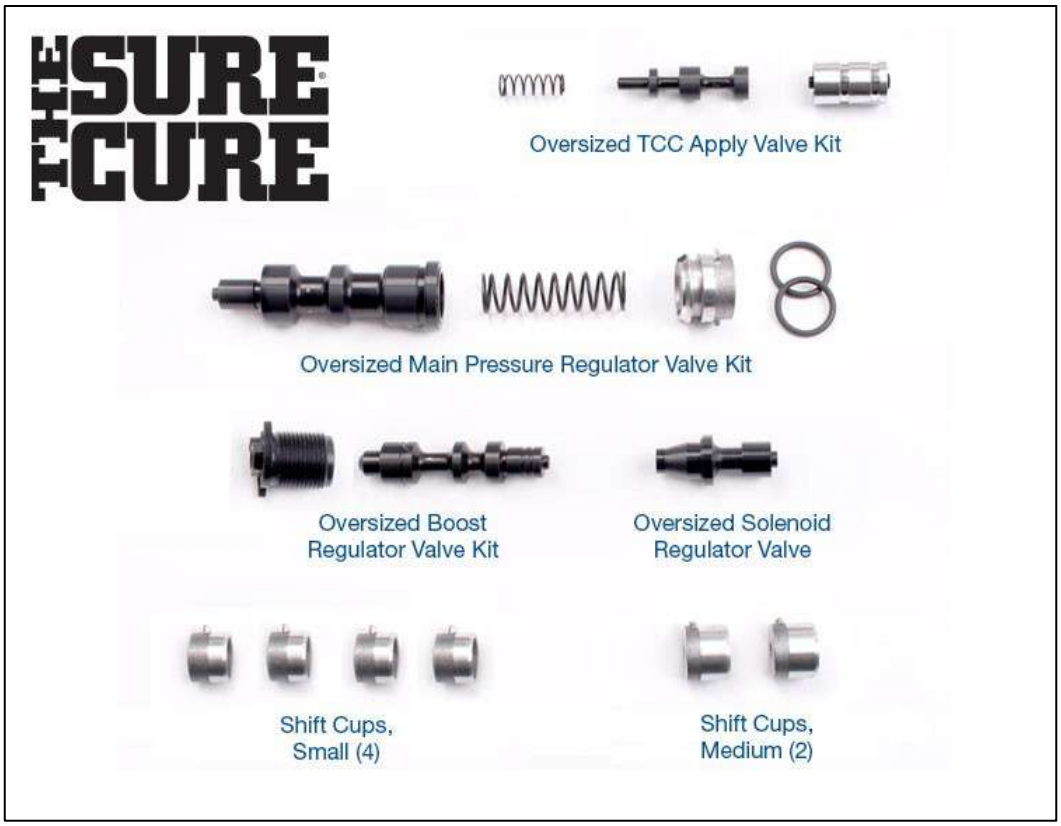
2- Correction Kit

Installation is highly recommended for heavier models, or high torque at low rpm models (TDI 102).
Resellers offer two brands of prescription kits for BVA 01M / 01P.

The Transgo shift kit exists only for 01P and therefore not to 098. It comprises a set of springs and replacement of pistons.

The hydraulic distributor (DH) must be in good condition, otherwise this kit will be ineffective. The high pressure piston is however provided with a seal to compensate a (low) ovalisation of the opening.

The instructions are in English and are well illustrated. The operation takes few hours and is within reach of a DIY.
It is less than $100 in the US. Allow a little extra ticket for postage and especially customs ...



A little more expensive, the Sonnax Sure Cure Kit uses oversized pistons, which requires a block reboring. For this type of surgery, it is highly advisable to go through a specialized workshop ... hard to find in France!

It’s a potential solution to a 098 box if the DH of 01P is too damaged to support a Transgo kit ???

3- New hydraulic distributor (DH)

By checking deals specially on British web sites, one can occasionally find a hydraulic block already reconditioned. As a bonus, some are already equipped with a corrector kit Transgo or Sonnax.
Beware of different versions: the DH has undergone many changes. Typically the seller indicates compatible vintages, but much caution should be used to insure compatible product with your own DH before ordering!

Using an adapted "Tourism" block (095/01M) instead of a "van" (098/01P) is possible - it is also the case on my 01P - but requires some retouching!
In this case, you will have to reuse the old block elements (piston + spring).

4- Transmission Control Module replacement/reprogramming

For those who encounter torque converter problems at low speed (eg TDI) because of low oil pressure, Sonnax recommends to replace the computer for a newer, which torques at a higher speed: Attractive solution, but it can be as expensive as replacing the whole converter!

It might be possible to reprogram the transmission’s computer to get the same result. If a specialist reads these lines it would be nice to hear from in order to get in touch with us.

If the torque converter problems persists, one can use the method recommended by RossTech to impose the "sport" mode. Consumption increases, but the converter lock suffer less! A temporary solution, fully reversible, quick to implement, thereby preserving the mechanical pending reconditioning of the BVA.

BVA Transmission internal components

Now it's time to go into heavier stuff!
For anyone interested in the T4 BVA and especially those who want to repair it or render it more reliable, don't miss this part.

Author's note: Since documentation and resellers infos use mostly written in English, I have tried to translate every useful term in that language so as to facilitate ordering parts, including in Germany to non-German speakers (like me).

Fluids

The most important BVA component is its oil, called Automatic Transmission Fluid, abbreviated ATF. Its quality guarantees the transmission: in respect for it's oil quality and replacement intervals (60,000 km or 30,000 in severe use): essential.

To avoid too much repetition, I will thereafter indiscriminately use the oil, fluid or ATF terms for all oils. As for all oils. the viscosity of the ATF decreases with heat.

A fluid can be modeled as an infinite number of small rigid balls whose diameter is inversely proportional to temperature. These beads roll against each other and are interposed between the moving parts, thereby preventing their friction and thus their abrasion.

On the other hand, the sealing of the various circuits oil is made possible only by the right viscosity of the ATF: for example, if one tries to inject air for check the sealing circuits BVA ... it will fly everywhere, the air does not have sufficient viscosity to remain prisoner there!

Overheating consequences

If the oil temperature exceeds the manufacturers' recommendations (~ 120 ° C max) (250 F), we are left with a cascade of problems:

- the viscosity decreases, the seals leak
- the piston receives less pressure, the force applied to the clutch decreases
- the remaining oil film between the plates and discs is more slippery, the adhesion decreases
- clutches slipping inexorably, causing additional heating: and it gets worse!
- to compensate for the slip, the computer increases the pressure applied to the pistons, which can deform or even break the piston
- the pressure also increases in all oils veins ... and increases the risk of leaks.

In short, if this pattern recurs regularly, it's assured internal destruction!

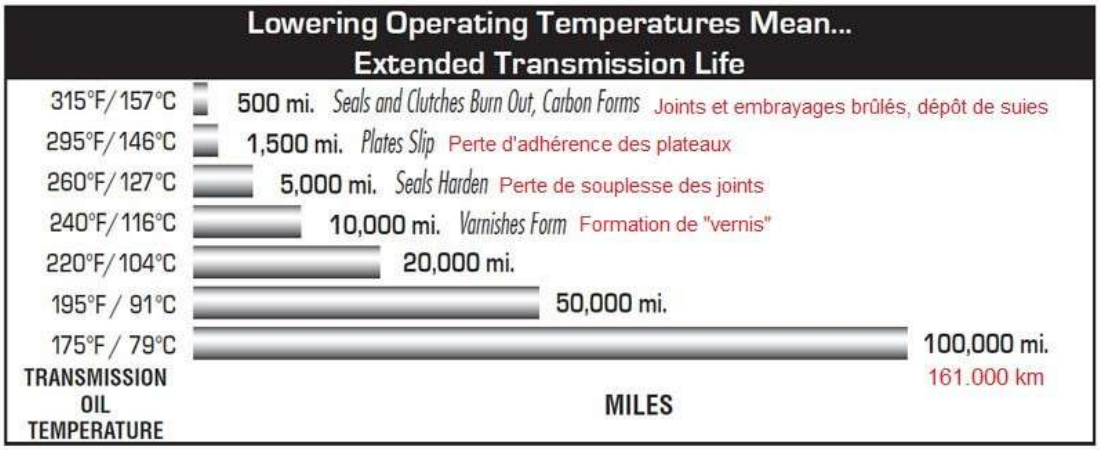
To top it all, beyond a certain threshold, the ATF vaporizes leaving a hardened residue, a sort of sticky "varnish" everywhere ... which can clog up the fine lines of the hydraulic distributor .

We see that the temperature control is the secret of any happy BVA! Alas, on this one, we can't say that VAG chose the right method, being confident/hoping that "the heat regulation" could the achieved by engine cooling system.

On older generations T4 (eg : 2.4D), the normal temperature was about 80°C and 95°C for the following models.

But on TDI 102, the "normal" temperature of the engine reaches the 105°C before the low speed fans launches, and even ... 120 ° C for high speed !

Lets keep in mind that the optimum temperature of the ATF is 90°C (190F). But if it gets too hot, in some severe conditions, it can quickly reach 140°C (280F). To maintain proper operation, it would then change the oil after 2000 km ... if you believe this chart!



Cold starts

Conversely, if the temperature of the ATF is very low, it is very viscous, struggles to flow ("beads" of larger diameter than the pipes!) and can deteriorate the BVA by over pressurization (and even abrasion!) if one overexerts it too much. That's why it’s advisable to let the engine run at park for a few minutes before taking the road.

Better to buy a vehicle with high Highway “mileage” than another one with "low mileage" ... but that has been in a succession of short runs cold!

Flywheel

On every BVA, the flywheel is a simple plate of pressed sheet metal, perforated with holes through which grips with the converter.

As with any BVManual flywheel, this tray also has a timing mark (TDC) for distribution. The starter ring, it is welded to the converter, which acts as a flywheel.

Starter

It is specific to the BVA: two fastening screws as of 3 for the BVManual.
The bearing bronze of the output shaft is lodge in the bell of the converter, and not in the starter. When replacing a starter, it may be essential to change too!

Torque Converter

The torque converter (or TC) as seen on the engine side.

The centering pin fits into the crankshaft, the three fixing bolts (6 on some models) to connect the flywheel.

A converter is somewhat similar to a conventional clutch, with one last detail that when the engine is idle ... it is as if the clutch was still fully depressed… the engine and transmission become independent. Thus, rendering impossible to start the vehicle by pushing it!

Another difference is that the power transfer from the engine isn't produced by friction plates, but by jet oil: the rotation propels the converter ATF to a turbine, fixed to the transmission input shaft.

The converter being sealed, I can’t show you the inside of my transmission. On the other hand. here is a exploded view of a different model, but all BVA are based on the same principle.

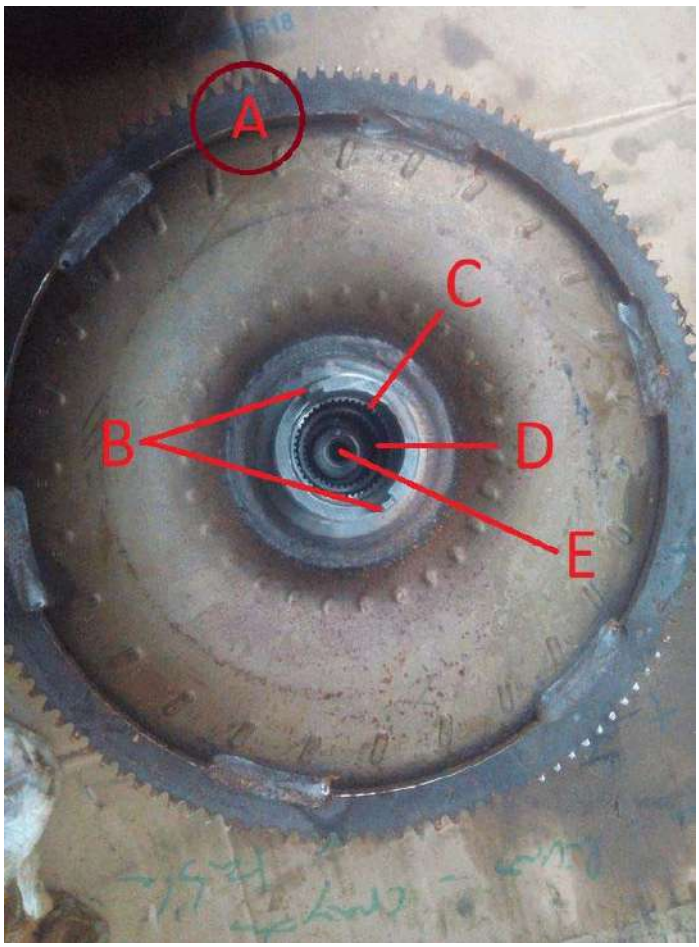
The "Bell" (1) is welded to the converter bottom (5) itself screwed to the flywheel, and thus rotates continuously. It is connected by a set of "fingers" to the oil pump of the BVA.

The "wings" or tilted blades stir up or actuate the ATF and propel it towards the turbine outward ring(3). The turbine blades transfer this rotation kinetic energy to the BVA by means of the small openings.

The fluid glides along the turbine blades, from the periphery to the center. It then returns to the bell through the stator (2). This part impedes the flow, and allows the turbine to remain under pressure. The stator also diverts the oil so as to redirect it in the desired direction, and thus increase the performance of the device.

When the turbine quickly rotates, the computer engages the clutch (4), which pushes it against the turbine (3) and the base of the converter (5), thus creating the gripping or sticking motion. This is often called locking, or lock (Lock-Up, abbreviated as LU) as described in the English literature. The engine speed and the wheels become completely proportional, and it seems to drive a manual transmission (BVM) ... but with no clutch pedal!

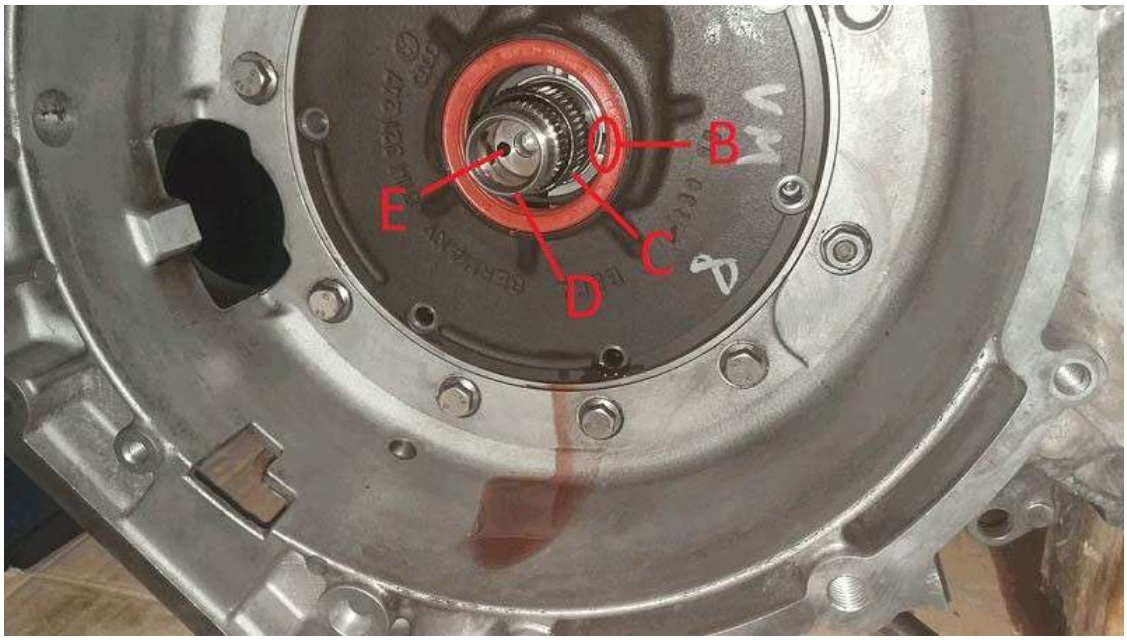
These five interior converter components should be self explanatory.



This picture shows:

A: starter gear ring
B: pump drive oil "locking pins" (ATF pump)
C: the stator grooves (held fixed through the body of BVA)
D: outlet flutes (towards the BVA). The equivalent of the primary shaft on a BVM
E: Controlling converter latch (oil feed)

Here are the equivalent component parts (male / female) on the BVA side:



External gear grooves (C) are fixed. The internal grooves (D) correspond to the automatic gearbox the input shaft which transfers the engine’s torque.

We can see the pump drive oil slots, which engage the two "pins" of the converter (B).
Note the hole inside of the central axis (E): this opening allows the ATF to flow, for driving the converter lock (or clutch). BVA’s are real Swiss Cheese!

Finally, we find bearings, to keep the shafts aligned, as well as roll bearings to prevent the ATF from leaking to the torque converter:
an oil seal (red) to allow low pressure fluid flow (B), behind which there is a bronze bearing to guide the converter (non-visible on the picture).
This bronze bearing, inserted at the end of the transmission input shaft. It serves both to maintain the axis (D) and the high pressure seal (E).

As an enhancement, it would be logical that this seal be supplemented by another joint, inaccessible, in the converter, which surrounds the shaft from the outside this time ...

Oil Pump

This part is the only BVA component that consistently runs with the engine. Without it, it would impossible to move the vehicle.

It consists of two concentric gears, between which the fluid is sucked and discharged.

Note the top of the outer ring shape. It serves keying editing.
Inward and outward oil flow are insured by openings located at the bottom of the image, opposite to the black "crescent moon".

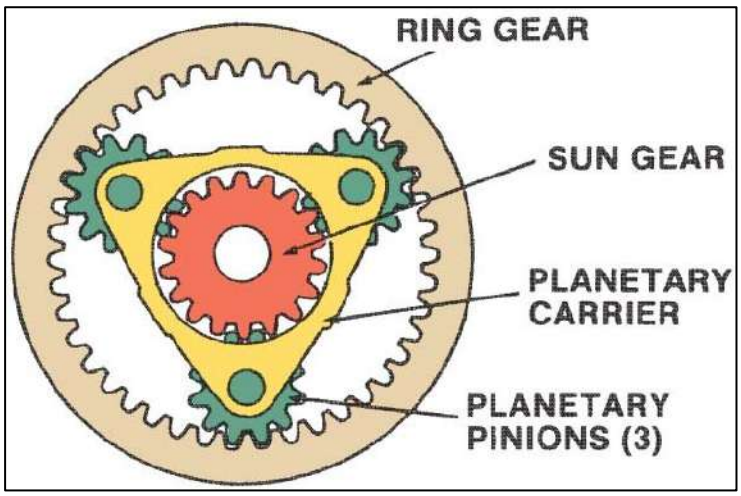
The larger is the input, connected to the lower filter located in the oil pan. This superfine filter must be changed with every oil change.

The smaller one are the high pressure oil outlets which flows to the hydraulic distributor (DH, English Valve Body, VB).

While the engine oil system is subjected to 5 bar pressure levels, the ATF is brought up to around 20 bar. Which actually isn’t much considering that some agricultural farm equipment and construction vehicle commonly turn at 100 bar or more.

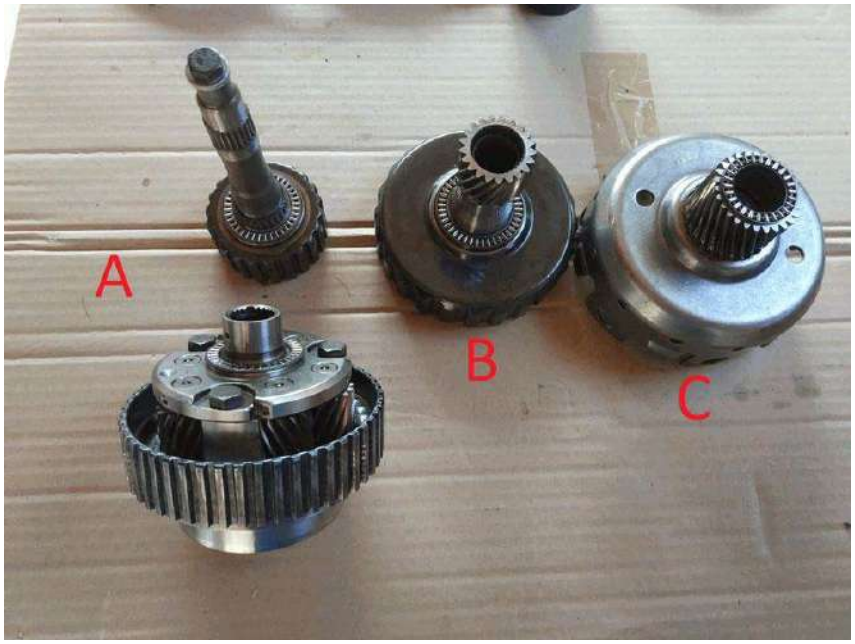
The pressurized fluid is distributed throughout the BVA, used both for various bearings lubricating and gear changes. The DH contains several regulators which reduce the pressure as needed.

Epicyclic gearing
(Tr note: also known as planetary gearing)



This is the actual heart of the BVA.
It provides 4 forward gears and one reverse. It consists of a set of gears, which blocks or releases that depending on the desired speed.

The input / output ratios are systematically identical, regardless of the any BVA.
The final drive is adjusted by a set of gears arranged downstream, depending on whether the vehicle is a utility slow or a fast car. A bit of both in the case of T4s!



AG4's designers showed some ingenuity by achieving a system occupying the least possible space.

This is what our planetary gear (planetary gearbox) looks like, disassembled, but leaving the crown intact (remained in place):

The picture shows the 3 drums and concentric shafts:

A- planet carrier
B- small sun gear
C- large sun gear

Side view:

The needle bearings separate each item as they rotate at different regimes.

Or not, depending on which gear is selected!

Front view:

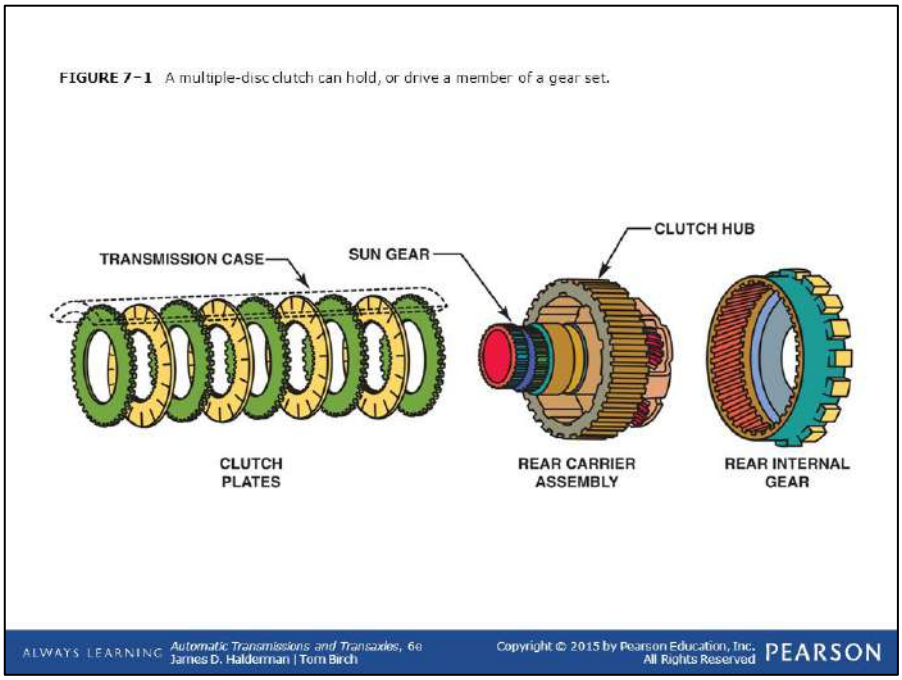
Planet carrier details

At first glance, all 6 satellites side by side gears may appear "identical", but closer look reveals that only those marked (C), driven by the large sun gear are linked with the output ring of the planetary gear train.

The other 3 (B) are driven by the small sun gear, before linking with the satellites (C).

All clutches and brakes layout stems from this design.

The Gears

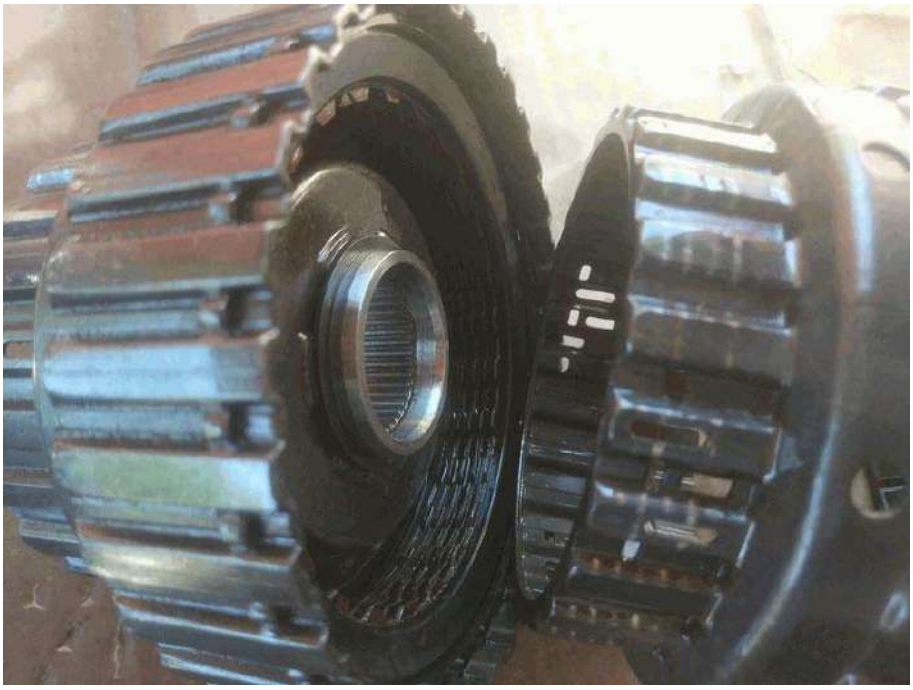


The AG4 BVA box includes 3 gears:

In German Kupplung, identified as K1, K2 and K3.

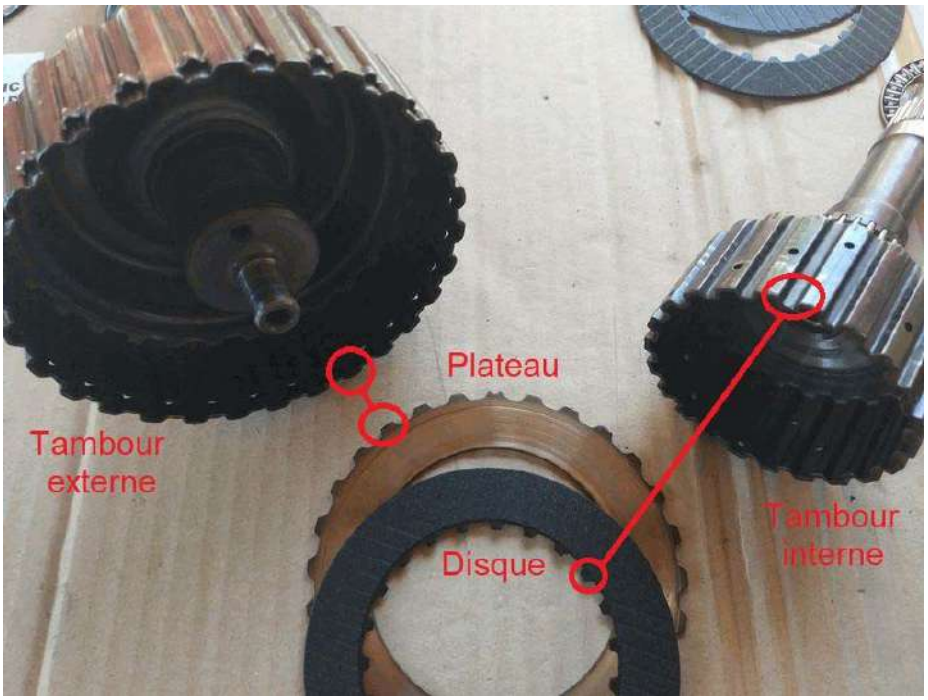
In the English literature they are sometimes referred to as C1, C2, C3.

They allow to join the three axes of the planetary gear with the transmission input shaft (the output of the converter):
K1: small sun gear
K2: large sun gear
K3 planet carrier



K1:exploded view

Housed in two concentric serrated drums, gears are actuated by a piston, supplied with oil by the hydraulic distributor, which is itself controlled by the computer.



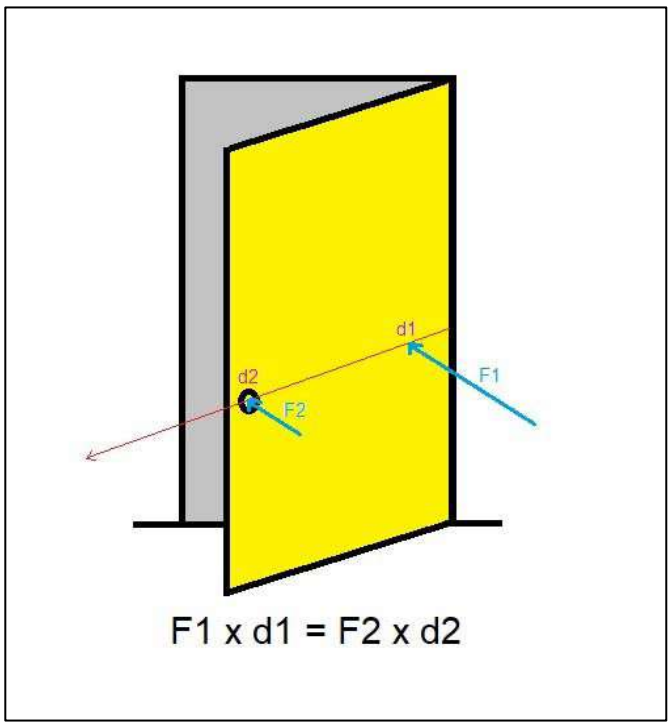
Discs and plates

The gears rest on an alternation of steel plates, and also metal discs, but coated with a thin layer of friction material. This can be for example graphite, but sometimes it's downright ... paper!

Disks (disk) are notched in the direction of the axis, thus secured to the inner drum.
And conversely, the metal plates have notches directed towards the outer drum.

When discs and trays are pushed against each other by the piston inner and outer ring are found joined together, and then turning the same speed.

Why multiple discs?



The closer to the axis, the more effort on parts friction is important.

To verify this, it's simple:
Try to open a door by pressing near its axis, rather than to maneuver the handle on the opposite of hinges: you will have to press harder for the same result.

C: torque to be transmitted
F: force
d: distance from the axis

The multi-disk system compensates for the small diameter clutches: stacking 5 double sided discs between 6 trays are distributed total effort cashed (F) on 10 different friction surfaces.

A equal torque transmitted, the smaller the diameter , the greater the number of discs needed to compensate.

Hydraulic piston

By definition, discs and trays are separated. You have to push them towards each other to put them in contact.

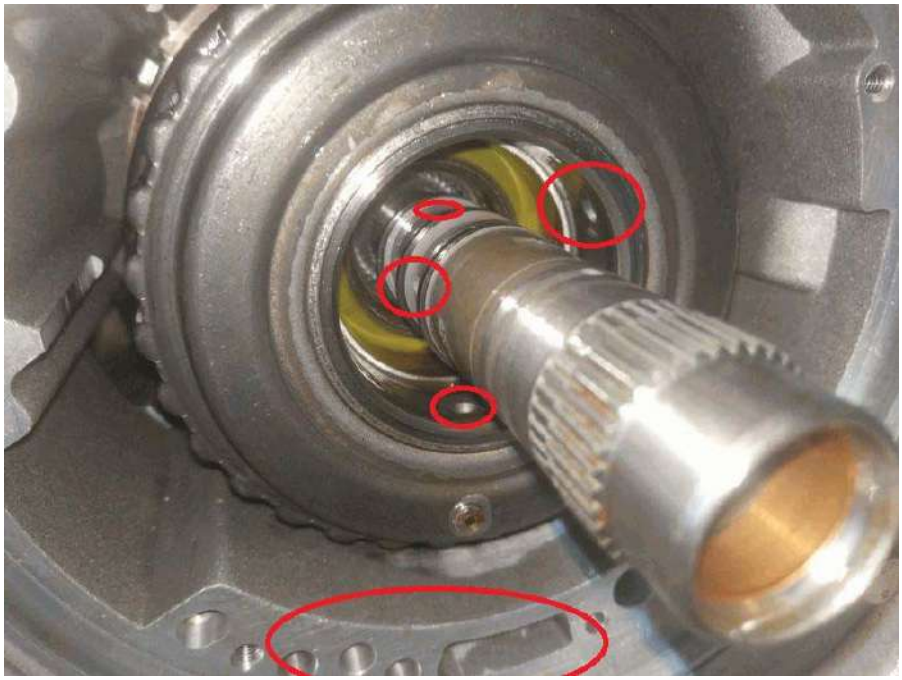
And this is done with an hydraulic piston ... very special!

This piston has two features which draws it apart from a traditional hydraulic pistons:

1- It is annular: it is a very thin ring which has the same average diameter as disks, so as to apply a steady force to the entire periphery of the clutch.

2- It spins with the trays.
Therefore oil can not brought to it by means of simple pipes!

Oil circuit



To travel from the hydraulic distributor to the piston clutch, the fluid passes through a series of holes drilled in the transmission housing and in pipes incorporated in the central hub, before joining the rotating drum containing the annular piston.

The axis main BVA comprises a series of segments, annular metal seals (oil sealing rings), which realize a rotating seal.

This axis is riddled with holes that put different "pressure vessels" in close contact.

As I said, a BVA is a real Swiss Cheese!

Internal brakes

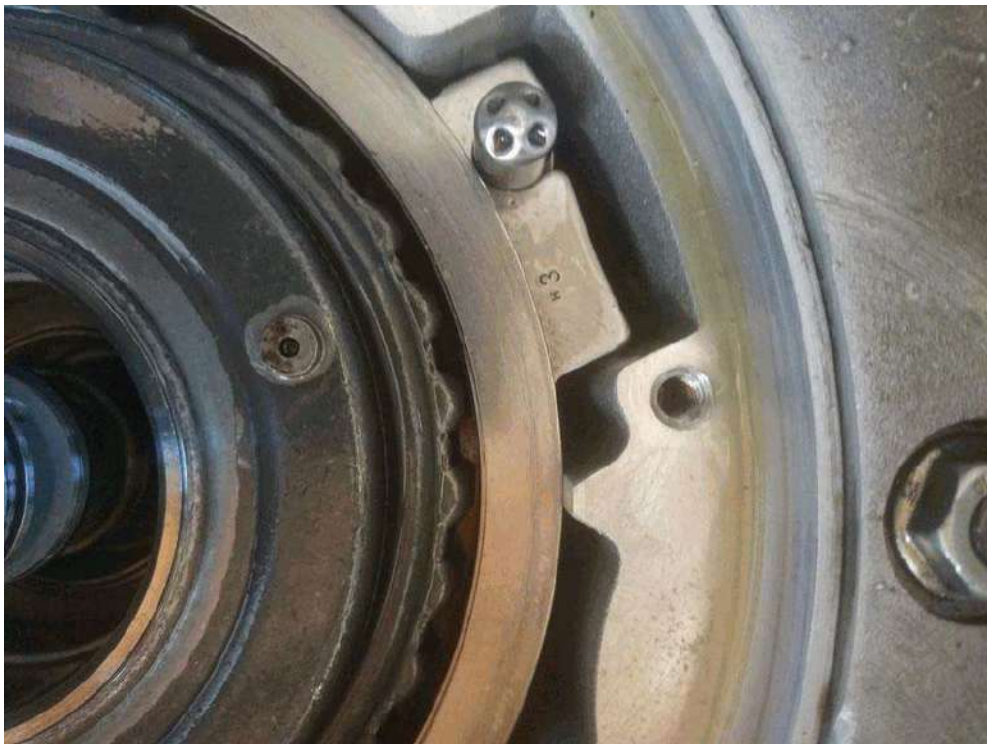
They’re two brakes in a Eurovan BVA (in German Bremse)

B1: planet carrier. When this brake is inactive, the assembly is in free wheel mode.
B2: large sun gear

Note that B1 is the only one partially visible without having to remove the BVA from the car.

We can see its disks from underneath when draining the ATF.

It can be tested by injecting compressed air in the little yellow tube.



This second brake isn’t visible at first glance.

The B2 brake is located opposite the oil pump, thus accessible only during a major review.

The piston which actuates it is discretely accommodated in the pump housing.

On some types of BVA (AL4), the brakes are strips that rub on drums. On AG4 by contrast, the brakes are much like clutches. Their discs and pistons have the same shape but have larger diameter, because they surround the rotating clutches.

The difference with this system steams to the fact that the metal plates rub on the brake, instead of being anchored in a rotary drum.

These rings are supported directly in the transmission housing, which prevents them from rotating.

Instead of a series of regular slots, so they have only a few pins which are received in corresponding notches provided in the housing.

Gear diagram

This diagram shows which brakes and clutches controlled by the computer in relation with each gear:

Rapport engagé	P	R	N	1	2	3	4
Petit pignon solaire				K1	K1	K1	
Grand pignon solaire	B2	K2			B2		B2
Porte satellites		B1		B1*		K3	K3

Note:

- In first gear, there is no converter lock, so no engine braking. To simulate this engine brake, the release of the accelerator the computer section K1 and actuates B1. The slowdown is so very effective, even on steep slopes, even at very low speed.
- In some literature, K1 is called "1-3" K2 "reverse" and K3 "3-4." We understand why.
- No brake needed (B3) to the planet carrier: it locks automatically if it is requested in reverse (gear 1 and R), thanks' to the freewheel system.
- Note the absence clutch (K4) to cause the output ring of the third ratio is obtained the same result by securing PPS and PS (K1 + K3).

By using this configuration instead of the theoretical model, the manufacturer has saved a brake and a clutch.

Parking locking pin

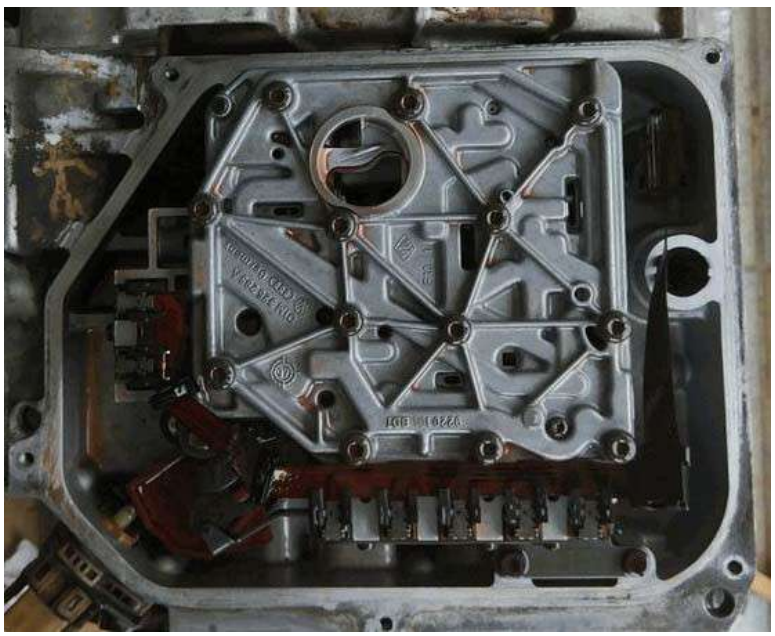

We have seen that in Parking mode, the engine and the wheels were never connected, so it is impossible to put a gear "engagement" to block the vehicle.

Manufacturers have long solved this problem by adding a P position for parking.
This mode consist of inserting a locking pin in one of the holes provided on the output gear of the automatic gearbox.

For obvious safety reasons, this position is required to engage the starter. There is no risk to starting the engine with an engaged gear.

In parking mode, rear parking brakes become optional and are even discouraged in cold climates (also true for BVM by the way!).

Hydraulic distributor



It incorporates driver commands and of the BVA computer sending the oil in the various corresponding circuits.

Stick shift release knob

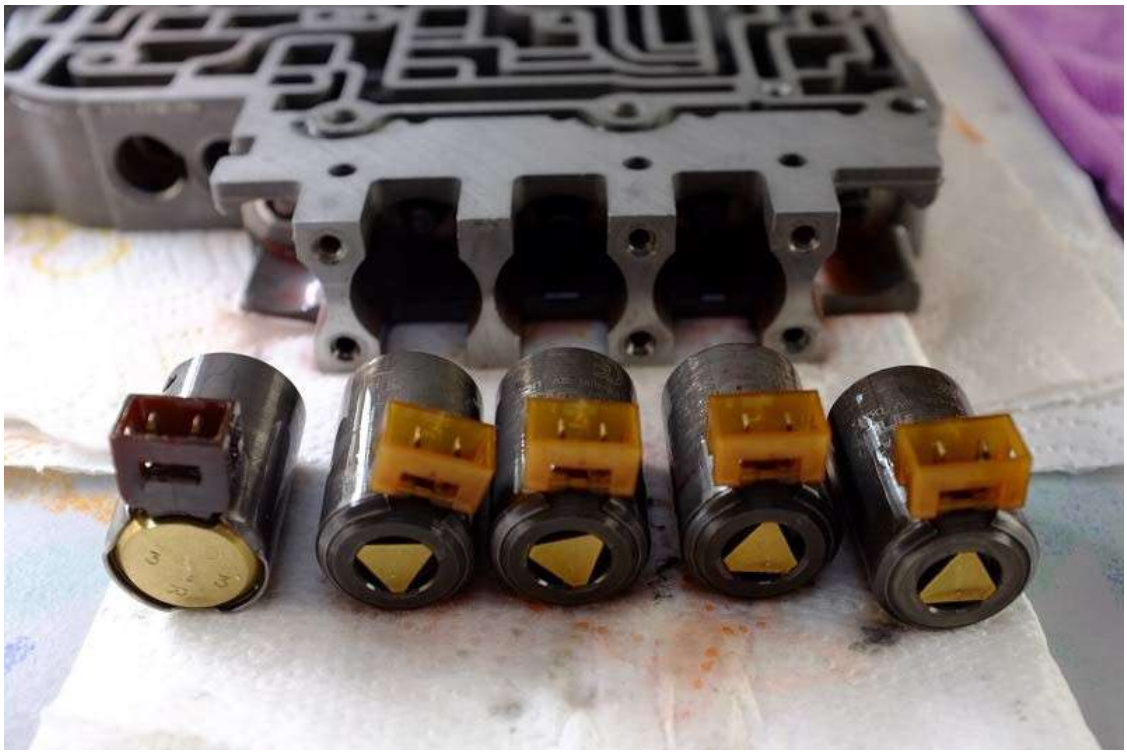
Operated by the driver, it operates both a multifunction switch (CMF), which informs the transmission computer on which gears to select and directs the flow of ATF by means of a small hydraulics plug . Thus there is no risk of accidental gear slipping, in case of electronic failure.

Multi Function Switch

Controlled by a set of cams and feelers, the CMF (Multifunction Switch) indicates the position of the selector to the computer.

Left the CMF
Right hydraulics plug.
Both visible during oil change.

The solenoids



They’re 7 solenoids all together. They’re connected by a frangible web to a circular connector, ensuring the connection with the computer. Please note that this table also contains the temperature sensor. The web is permanently immersed in oil.

Five of these valves control "all or nothing" opening or closing circuits, the last 2 are variable control (PWM), allowing for a smooth gear shift.

Solenoid valves table in relation with gear selection.

Rapport	EV1 (N88)	EV2 (N89)	EV3 (N90)	EV4 (N91)	EV5 (N92)	EV6 (N93	EV7 (N94
P ou N	x		x			x	
R			x		x	x	
1			x	x	x	x	
2		x	x	x	x	x	
3				x	x	x	x
4	x	x		x	x	x	x

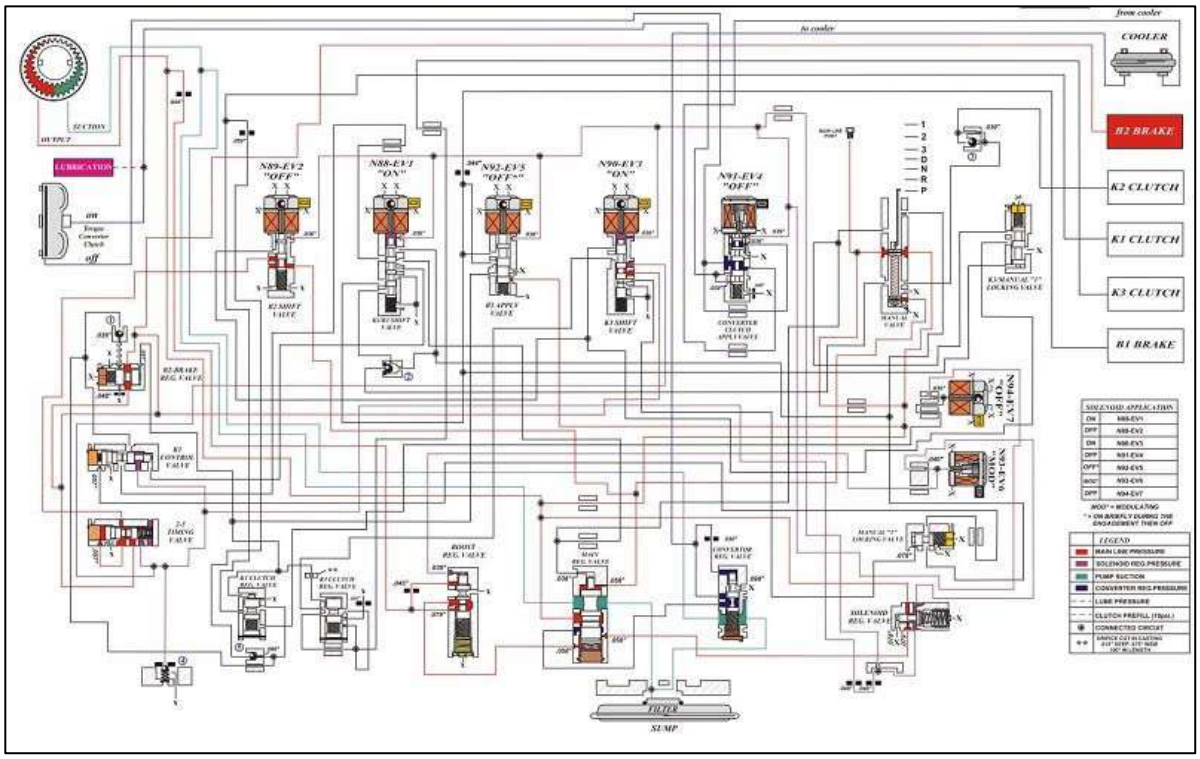
Please note that depending on the gear selection, a solenoid valve may have a different function.

- EV1 actuates sometimes K1, sometimes B1, depending on the gear selection
- EV2 actuates B2 (gears 2 and 4)
- EV3 operates K3
- EV4 used only in case of converter lock (lock up).
- EV5 is activated momentarily during gearshifts to reduce the pressure applied to the clutch, so as to avoid jolts.
- EV6 regulates the pressure in real time depending on the engine load, the coolant temperature ... In case of cut off EV6 the pressure remains up and gear changes become brutal!
- EV7 modulates the pressure applied to the brake unit B2 in the gear change from 3-4 or 4-3, and very briefly during the passage from 2-3…. in order to prevent jerking.

Hydraulic distributor diagram

The hydraulic diagram is by definition very complicated. Some electricians sometimes compared it to an electrical diagram.

The positive pole is a pressure point, the negative pole of the return oil to the sump, and the wires...
a succession of chambers and pipes, real "secret passages"… when looked at by an amateur!



In the same way that each wire of an electrical schematic is marked, each element of the DH is numbered, allowing the hydraulic engineer to easily understand the oil flow, as an electrician would do during building construction.

To top this analogy, they are different pressure levels, provided by a set of hydraulic regulators, filling the same role as a switching power supply to a computer!

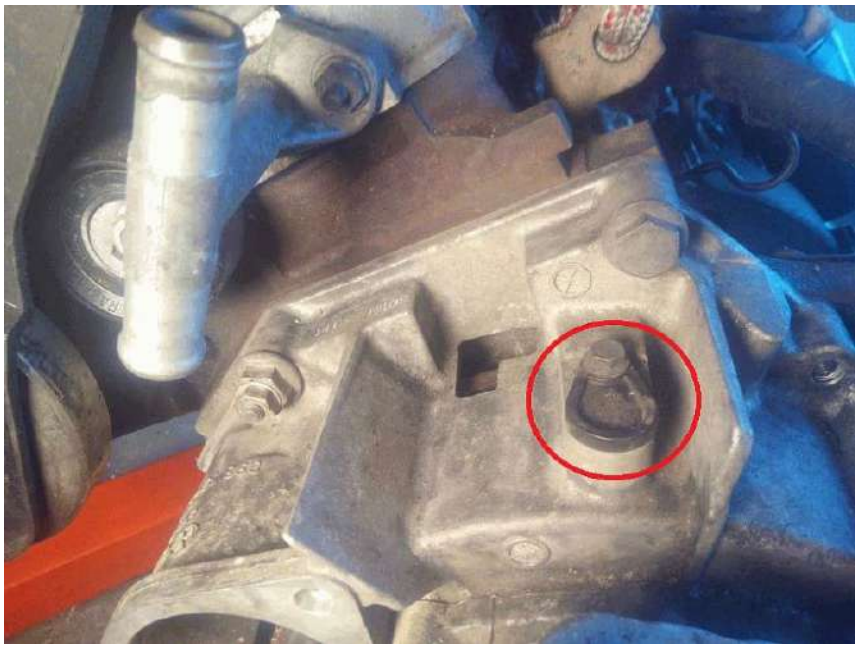
- A low-pressure line pilot solenoid valves: the electromagnets just give the "flicking" needed to release the oil, which it will move a piston.
- A high pressure line supplies the cylinders circuit (Bx and Kx)
- A separate high pressure line is connected to the converter lock (lock-up).
- A high pressure bypass passes through the external cooling circuit (on top of the BVA).

BVA speed sensors

The BVA houses 2 or 3 magnetic reluctance sensors, robust and reliable (similar to some present on ABS rings)

Thanks to them the computer knows which gear is engaged and if the clutches and brakes are functional.

Engine speed sensors



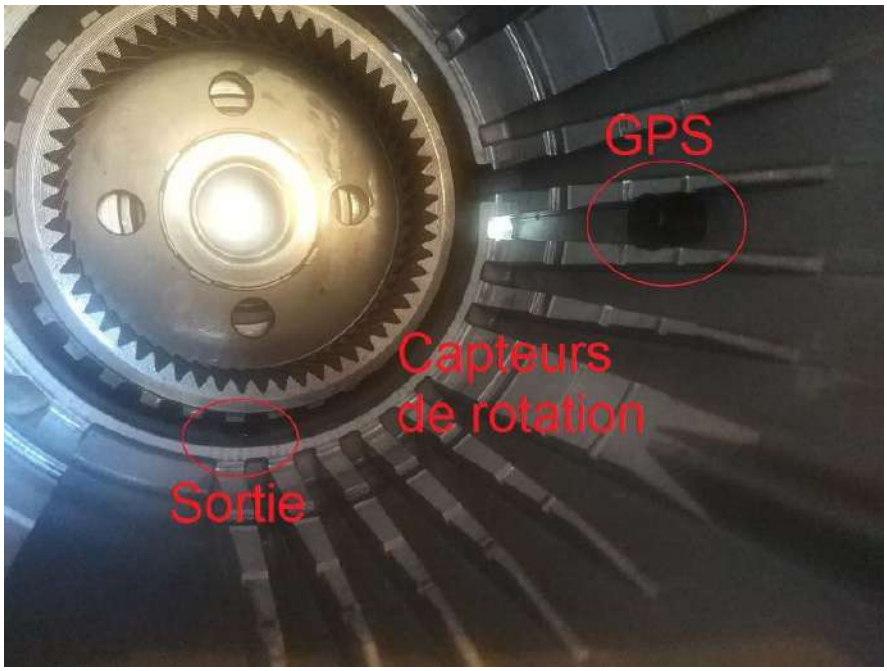
It’s located on the bell of the torque converter bell housing.

The VR6 or the TDI don’t have any since their transmission computer is informed of the engine speed by means of the engine control unit (ECU).

We only find this type of sensor on non electronic engines (eg AAB).

Otherwise it's a plug.

Grand solar pin
Tr note: Direct translation from the Grand Pignon Solaire (GPS)
Not to be confused with global positioning system.



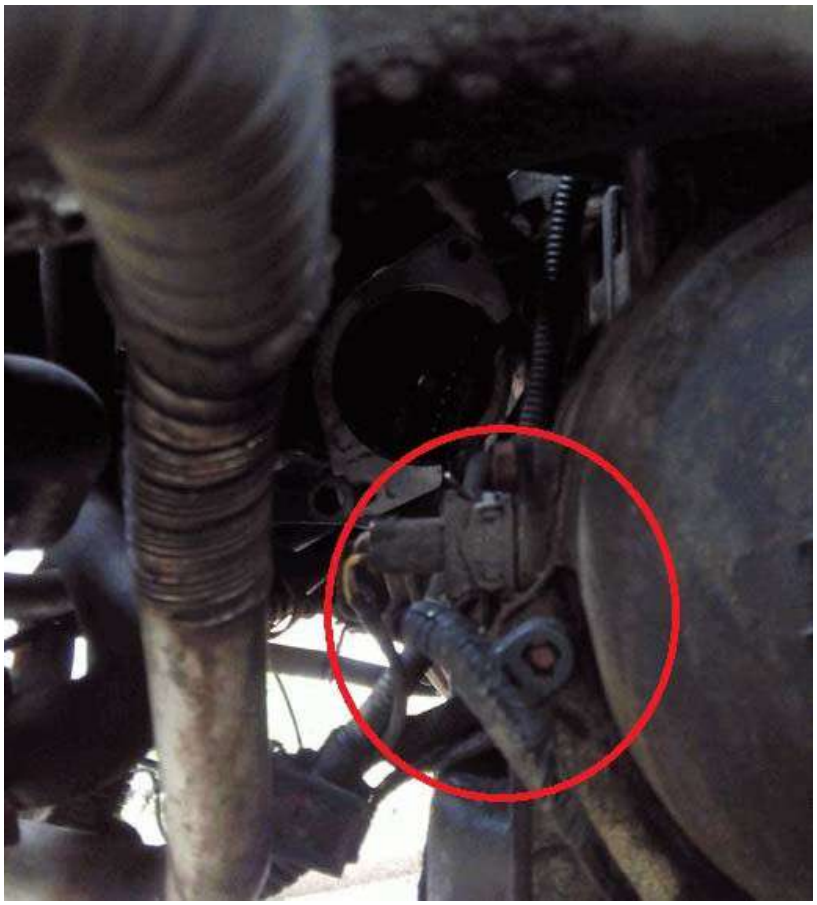
The GPS and the clutch braking mechanism associated (B2 / K2) are far apart from each other.

Their connection are provided by a odd shape cylinder, called Shell in English.

The sensor on top of the BVA and delivers pulses that reflect this rotation of the cylinder.
NB. This sensor is absent on the 098: it is found only on the 01P.

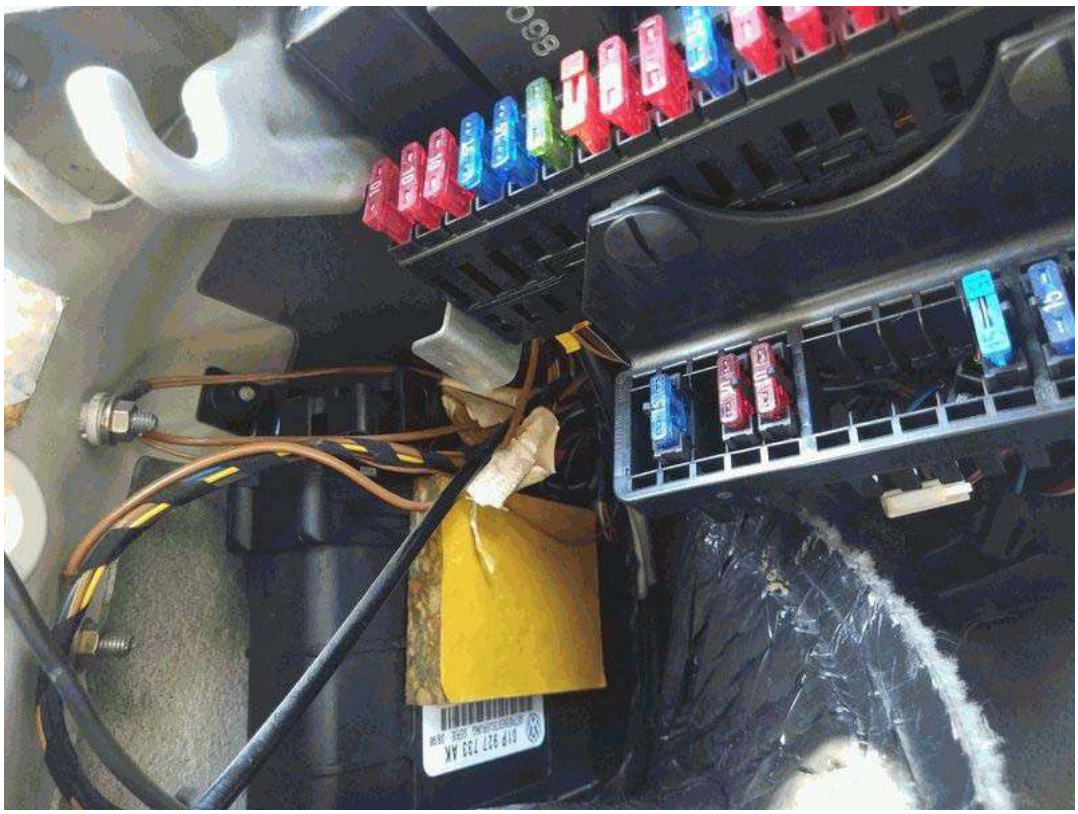
Exit point. Tr Note: Sortie.
Placed on the front, near the filler neck, it gives the output speed of the epicyclical gear.
It is the rotation of this axis which drives the wheels through two gears giving the final drive.

Beam (electric pulse)



The BVA has its own electric pulse which links the transmission's computer (TCM) to hydraulic distributor.

Transmission Control Module



Called in English ‘’Transmission Control Module’’ or TCM. It can be found in the passenger cabin, on the right side on the first-generation models, or on the left side, close to the inner wheel housing, on newer models.

NB: In case of corrosion of the windscreen bay, water infiltration can damage the connector and cause a malfunction.

Input information

Depending, these information's are obtained by dedicated sensors, or by direct feedback by the TCM.
It actually depends on the T4's build date and engine specs.

By the driver

- Switch position (CMF)
- Brake pedal (to demote)
- Gas pedal (idling contact, potentiometer, kick down)
- Cruise control

By the engine control unit (ECU, engine control unit)

- Engine reving and torque
- Fuel flow (hill clime)
- Air Conditioning Yes / no
- Oil temperature ATF etc.

Note: In the absence of ECU, the TCM processes itself these information using dedicated sensors.

By the BVA itself

- Oil Temperature (by means of the solenoids)
- Planetary gear housing

Output information

Besides the solenoid valves controls, the TCM lights the tail gate lamps and the gear display on the instrument cluster through the CMF- Multifunction Switch.

It also sends information to the ECU, which can then act accordingly, as speed or conversely stop injection, the time of a shift, for example ...
The TCM also insure of obtaining planetary gear synchronization which greatly limits clutch wear and increases passenger comfort by reducing older BVA's jerky gear changes.