JATCO CVT and DaimlerChrysler,

by Sean Boyle

Part 1 An Overview and a Look at Power Flow

DaimlerChrysler has joined the ranks of many manufacturers offering a Continuously Variable Transmission (CVT). The 2007 Jeep Compass, Patriot, and Dodge Caliber come equipped with an optional CVT produced by JATCO. According to a local Dodge dealership, they can't keep the CVT Calibers in stock. This dealer sold the first fifty Calibers within a month and is anxiously waiting for more.

This CVT isn't new technology; in fact, the unit is similar to the CVT found in many Nissans since 2002. In this article, we'll focus on the mechanical and hydraulic operation of the JATCO CVT used in DaimlerChrysler vehicles. In the next issue, we'll look into the electronic and computer control systems.

It all begins with the basics, and nothing gets more basic than checking fluid, right? The CVT uses a special fluid, designated *CVTF+4*, which is specifically designed for the CVT. According to DaimlerChrysler, the unit requires this special fluid because of the "higher pressure, special metal alloys, and the critical need to prevent belt slippage." For ID purposes, the fluid is *green* and, according to the manufacturer, even a small amount of regular ATF will cause severe damage to the CVT. The one-quart bottle is part number 05191184AA and the five-gallon jug is part number 05191185AA.

Checking the fluid in the CVT isn't straightforward. In fact, the procedure follows along the same lines as the NAG (722.6) and even the new 62TE. There's no dipstick; customers are encouraged to take their vehicle to a repair facility every 15,000 miles to have a trained technician check their fluid. A special tool, Miller part number 9336, is used to check the level, which depends on fluid temperature. Since the fluid level can change almost 12mm from 70ºF to 190ºF, the level must be checked with the 9336 dipstick and cross-referenced to a chart or table. From the bottom of the internal stop the fluid level should be:

Temperature	High	Low
77ºF	38mm	25mm
138ºF	42mm	29mm
191ºF	46mm	34mm

The fluid is expected to last the life of the vehicle, but maintenance schedule B (which pertains to most vehicles) would require the fluid to be changed every 60,000 miles. According to DaimlerChrysler, schedule B includes vehicles driven under any of these conditions:

- At temperatures below 32ºF (0ºC).
- Stop and go.
- Extensive engine idling.
- Dusty conditions.
- Short trips of less than 10 miles (16 km).
- More than 50% at sustained high speeds during hot weather, above 90ºF (32ºC).
- Trailer towing.
- Taxi, police or delivery service (commercial service).
- Off-road or desert operation.
- Heavy loading

Mechanical: External

A quick look at the CVT reveals two Hall Effect speed sensors (ISS and OSS), a transmission range sensor (TRS), a water-to-oil cooler, and a multitude of pressure taps. The components are labeled on the following pictures (Figures 1, 2 & 3, see next page).

There are pressure taps all over this transmission, but don't just plug any pressure gauge into these ports. Use a gauge that's rated for at least 1000 psi. Typical operating pressures can easily approach 800 – 900 psi to ensure necessary side force on the CVT belt (Figure 4, see page 40).

When montoring pressures, you'll see the secondary variator pressures peak momentarily when rolling to a stop. This lowers the effective ratio before the vehicle comes to a complete stop. Once the transmissions stops rotating, the CVT can't change ratios, because the variators need to rotate to change ratios; more on that later.

Refer to Table A for typical pressures.

Mechanical: Internal

The secrets of the CVT are found within the transaxle. Here you will find two variators (pulleys), a steel belt, a high-pressure oil pump, a valve

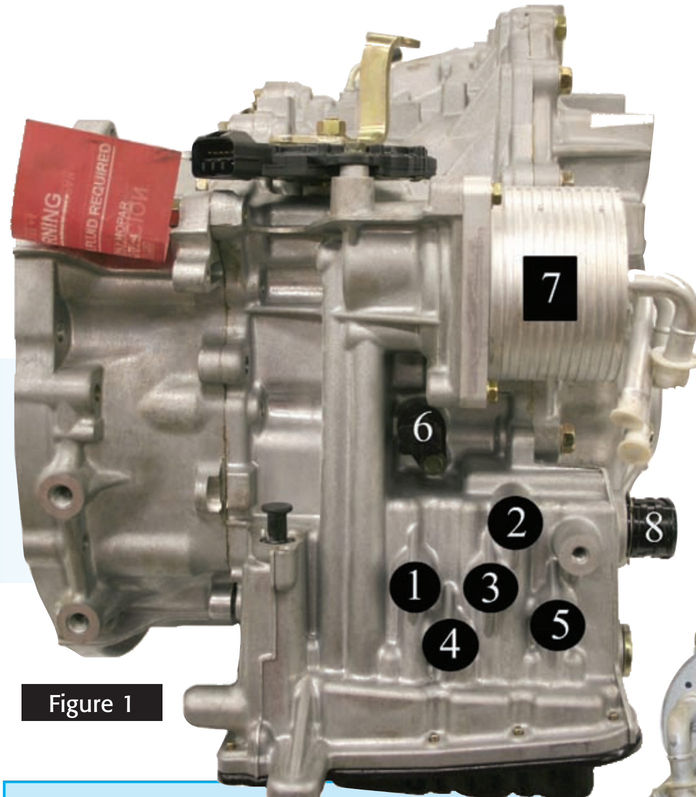


Figure 1

JATCO CVT ID

1. Line Pressure
2. TCC Release
3. Primary Variator
4. Forward Clutch
5. TCC Apply
6. Input Speed Sensor
7. Water-to-Oil cooler
8. Pass-Through Electrical Connector
9. Secondary Variator
10. Reverse Clutch
11. Trans Range Sensor
12. Output Speed Sensor

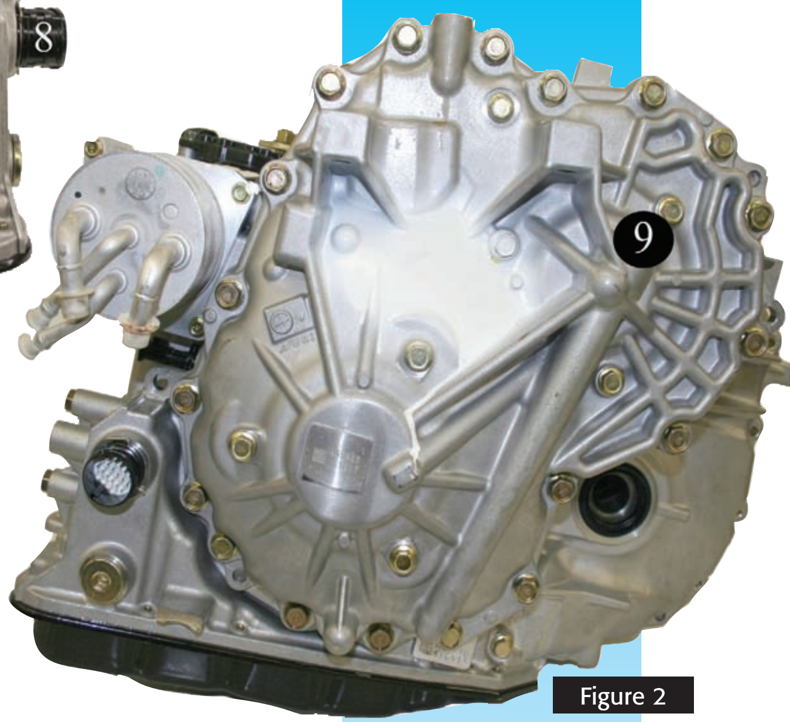


Figure 2

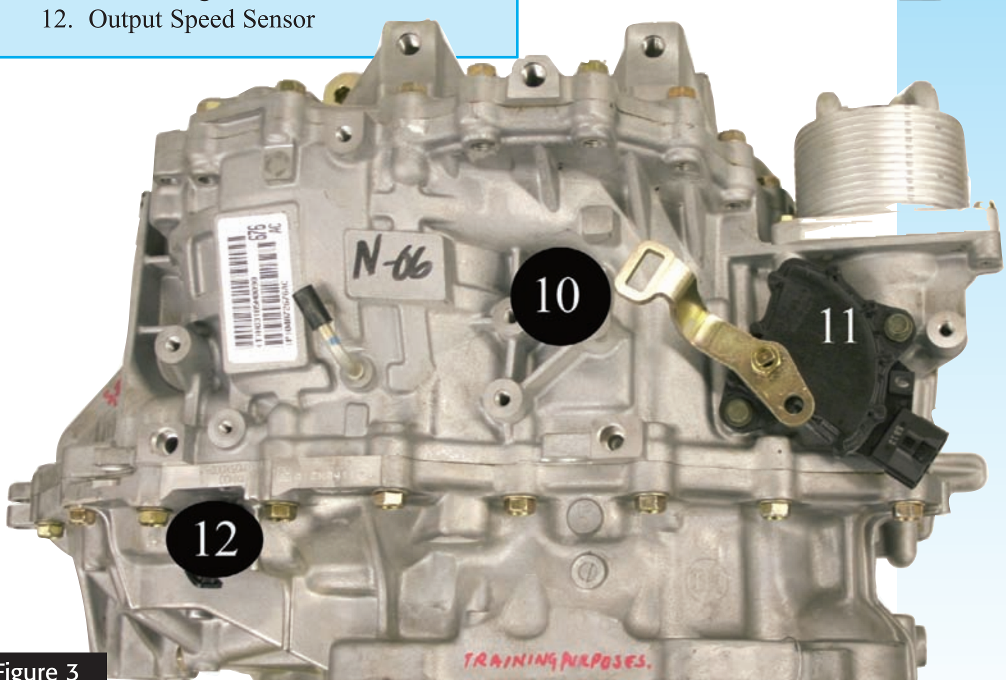


Figure 3

Figure 4

Table A

	Min - Max Pressures (psi)	Typical when when Idling (or Lockup for TCC Apply)
Line Pressure	72 – 870	72 – 218
Forward Clutch	15 – 218	72 – 145
Primary Variator	15 – 870	15 – 218
Torque Converter Apply	0 – 145	0 – 102
Torque Converter Release	0 – 145	0 – 102
Secondary Variator	15 – 870	15 – 218
Reverse Brake	15 – 218	72 – 145

body loaded with solenoids, a planetary gearset (oh yes, these units still have a gearset for reverse operation), and a couple clutch packs (for forward and reverse)(Figure 5).

A quick study of the CVT shows that its operation is as simple as the sprockets of a typical bicycle. Instead of a chain, the CVT uses a belt that rides on the pulley surfaces (sheaves) of the variators. To change ratios, the variators change their effective diameter.

The primary variator connects to the input shaft through the forward clutch assembly, which applies in all forward ranges. The primary variator pushes the secondary variator with a special segmented steel belt. The TCM is in control of the ratios by modulating solenoids that modify hydraulic pressure at each variator.

The TCM can change the dimension between the two variator pulley surfaces. This allows the belt to ride low in the primary variator (simulate small gear) or ride high in the primary variator (simulate large gear). By changing the variator position, the TCM can

Figure 5

acheive any gear ratio between 2.349:1 and 0.394:1.

The only component connecting the variators is the belt. Similar to the Honda CVT, the belt assembly is made up of many ridged segments shaped like wedges and held together by a layered steel belt. The belt is a *pusher*, not a *puller*, which means the primary variator uses the belt to push the secondary variator.

The concept involves the fact that steel cannot be compressed, so the belt shouldn't wear (and definitely not stretch) over time. Since the segments are designed with interlocking dowels, it acts like a solid steel structure when transfering torque from one variator to the other. This design is very different from the ZF design, which uses a chain and pins where one variator pulls the other.

With all CVT designs, pressure is the key component to making them survive. Belt slip within the sheaves (pulley surfaces) will quickly destroy the belt. This is why CVTs have such incredibly high pressures and special fluids.

Powerflow

Powerflow comes down to the basic concept of "a small gear driving a big gear equals underdrive" and so on, except in this case, there are no gears to speak of. Sure, there's a planetary gearset, but it's only used to get the sheaves to rotate in the opposite direction for reverse.

In reverse, the forward clutch is released and the reverse clutch applied, holding the carrier to the case. Power flows clockwise through the input shaft to the annulus gear. Since the carrier is held, the sun gear will be forced to rotate counter-clockwise. The sun gear is connected to the primary variator and, as simple as that, you have reverse.

The pulley ratio is locked in reverse to prevent overacceleration. This is necessary since the potential is there for the engine to remain at a constant speed while the transmission changes ratios. A customer may not realize it, but the vehicle *could* (if allowed) accelerate faster in reverse than in forward range. This is why they lock the ratio in reverse: to prevent highway speed

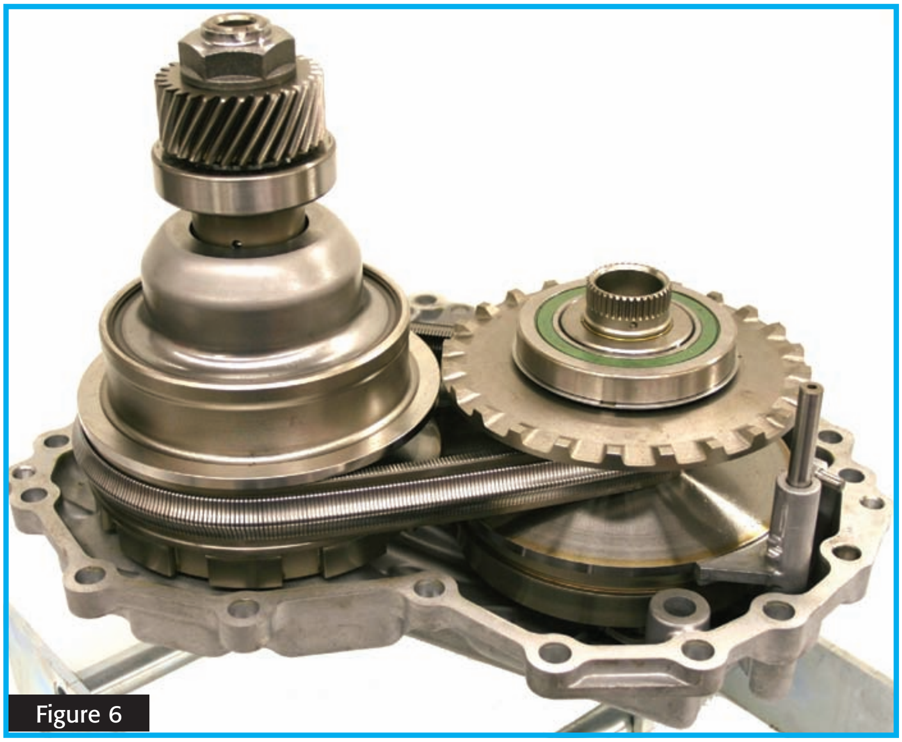


Figure 6

lets off the throttle and enters cruise, the TCM commands a higher ratio to reduce engine RPM and improve efficency and economy.

If the driver holds the thottle steadily from a standstill, the TCM will allow engine speed to increase to a point, then hold it there. The vehicle will simply continue to accelerate.

It's a pretty interesting experience to drive a CVT-equipped vehicle for the first time. Not only do you expect a shift, but sometimes you lose perspective of how fast you're driving, since the engine isn't connected directly to the drivetrain through a specific gear ratio. I've grown accustom to hearing the engine hum, which I can subconciously translate into vehicle speed. With a CVT, the engine could be humming at that same RPM all day with the vehicle cruising at a variety of speeds. It just takes a little getting used to.

driving in reverse (Figure 6).

With the selecter in drive or low, power flows from the torque converter, through the input shaft, through the applied forward clutch, to the sun gear/hub assembly. The sun gear/hub is splined to the primary variator, so the input basically bypasses the planetary gearset. Since nothing is held, the gearset just idles as in neutral.

As previously mentioned, the TCM is in complete control of the ratios. During acceleration, when the driver wants power and speed, the TCM commands a lower ratio, which increases engine RPM to provide maximum torque and horsepower. Once the driver

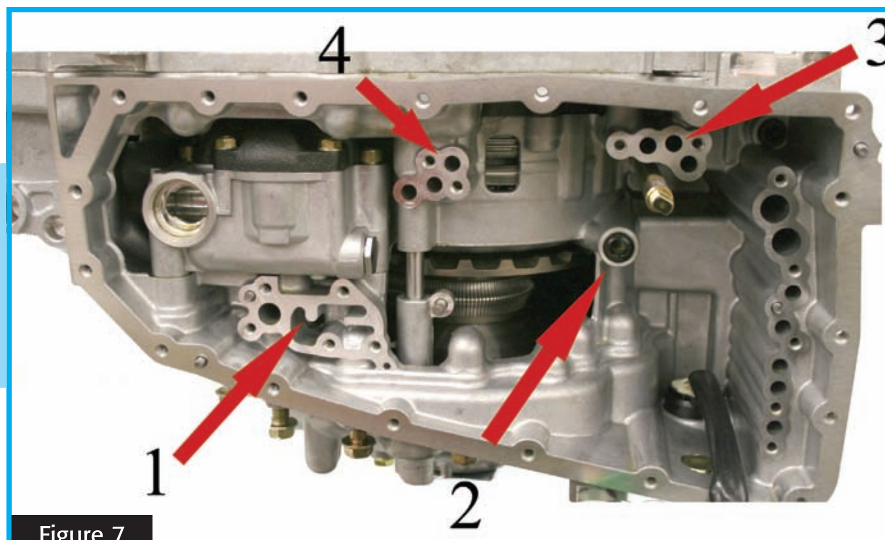


Figure 7

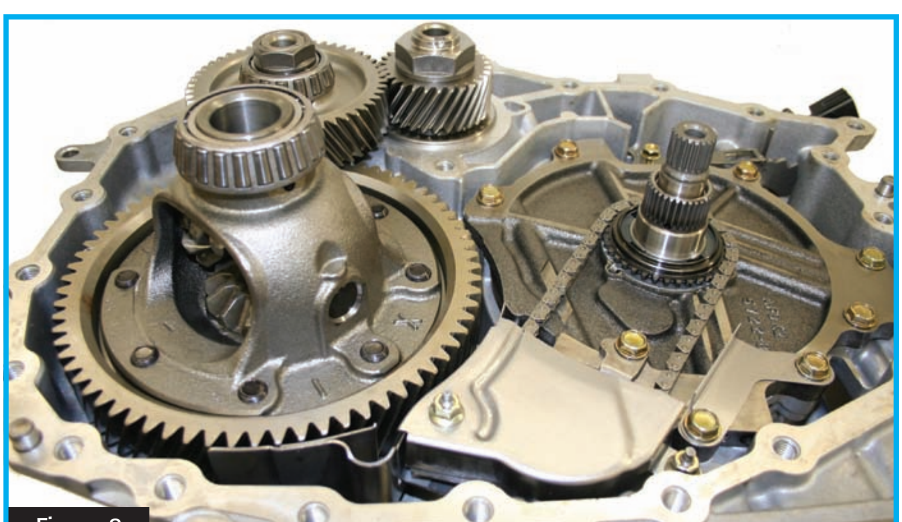


Figure 8

After the torque flows through the variators, it's multiplied through an idler gear assembly and final drive assembly. The idler gear assembly multiplies the torque by 1.72; the final drive multiplies the torque by 3.55. The overall ratio range is 14.34 for low, and 2.44 for high. This is pretty typical from one extreme to the other in comparison to a conventional transmission (Figures 7 & 8).

That's enough for now; in the next issue of *GEARS*, we'll look at the control system of the JATCO CVT, including the valve body, electronic controls, and the computer codes related to diagnosing this new transmission.

Just the right pressure

The Sonnax Oversized Pressure Regulator Valve for the A540E can save you up to $200 in valve body replacement costs.

COMPLAINT

SECONDARY COMPLAINTS

Low/high line pressure, soft/harsh shifts

• Clutch and band failures • Low converter pressure • Loss of lube

CAUSE

Continuous oscillation of the pressure regulator valve causes valve body bore wear, which results in line pressure irregularities and valve instability.

CORRECTION

The oversized valve allows the valve body to be refurbished and the hydraulic integrity restored for proper pressure control.

Oversized Pressure Regulator Valve

For application A540E, (1998-2000) with "A540Y" stamped on valve body

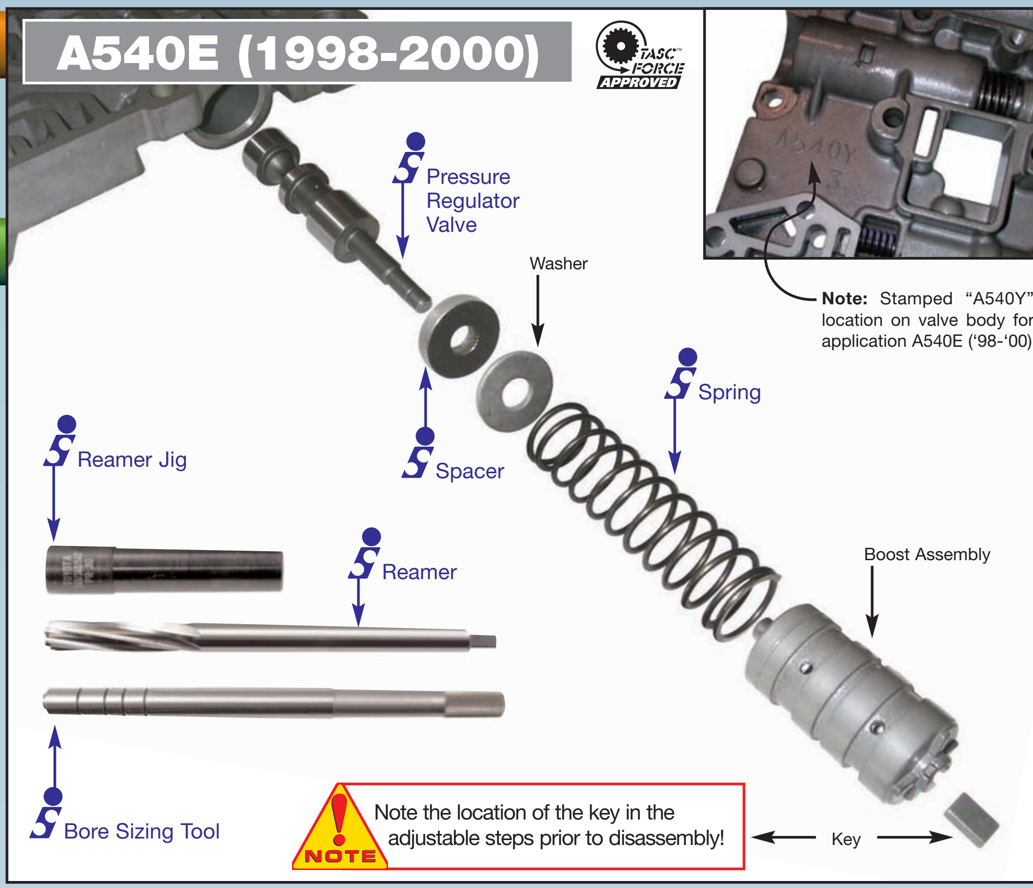
89010-04K

1 Valve
1 Spring
1 Spacer

TOOL REQUIRED

89010-TL

1 Reamer
1 Reamer Jig
1 Bore Sizing Tool



The continuous oscillation of the pressure regulator valve in A540E units wears the valve body bore. If severe wear occurs at the balance line circuit, the pressure regulator valve won't stroke to reduce line pressure and feed the converter/lube circuits. This can result in high line pressure, harsh shifts, reduced converter pressure and loss of lube. Severe wear at the other pressure regulator valve circuits can allow line pressure to exhaust or go to sump, resulting in low line pressure, soft shifts, and burned clutches and bands. The Sonnax oversized valve **89010-04K** is made from hardened steel for better wear resistance and the kit includes a new spring to maintain proper pressure specifications. The required tool kit **89010-TL** also works with existing Sonnax kits **89010-03K** (A140E, A240E, A540E '88-'93) and **97855-24K** (A340E).

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