

POWERTRAIN

ZF's DCT Fighter

New 6-speed auto eager to please in BMWs

By Tom Murphy

BorgWarner Automotive struck pay dirt in 2003 when its dual-clutch transmission (DCT) arrived in a few Volkswagen AG models and changed forever the face of the gearbox market.

Until the DCT came along, there essentially were three flavors of automotive transmissions: automatics with torque converters, manually shifted units with pedal clutches and a few "automated manuals" that were jerky and unsatisfying to drive.

With DCT, BorgWarner proved there is room for a transmission that functions like an automated manual but can provide quick, clean, sporty shifts and that also can be switched easily to full automatic mode for daily commuting.

The DCT, which VW markets as its Direct Shift Gearbox (DSG), met instant acclaim in the VW Golf R32 and Audi TT (and now offered throughout the VW and Audi product family), largely because it virtually eliminates the annoying "torque interrupt" between gears that has hindered automated manuals and a number of less sophisticated automatics.

Today, the market is evolving as continuously variable transmissions ramp up to respectable volumes and as BorgWarner competitors strive to outdo the DCT.

ZF Friedrichshafen AG is among them. It was first to market in 2001 with a 6-speed automatic, and its second-generation unit has arrived in recent months in the BMW 335i coupe and X3 and X5 cross/utility vehicles.

This second-generation 6-speed automatic uses a new torque converter that improves the connection between the driveline and the engine.

In combination with optimized software control and hydraulics, the new gearbox cuts shift times by 50% and is

expected to improve fuel economy by 3% with gasoline engines and 6% with diesels, ZF says.

The new 6-speed has five clutch packs. In varying order, each clutch is engaged by applying hydraulic pressure to squeeze together two parallel friction plates to engage the next gear.

Sophisticated control algorithms vary the speed at which those friction plates are squeezed.

For instance, in normal drive mode, pressure is applied more gradually for conventional, slightly lazy shifting. In sport mode, the clutch plates are pressed together rapidly to deliver the sportiness driving enthusiasts crave.

Reaction times for the new transmission are impressive. ZF says manual downshifts occur in about 200 milliseconds, while its first-generation 6-speed auto required at least twice as much time.

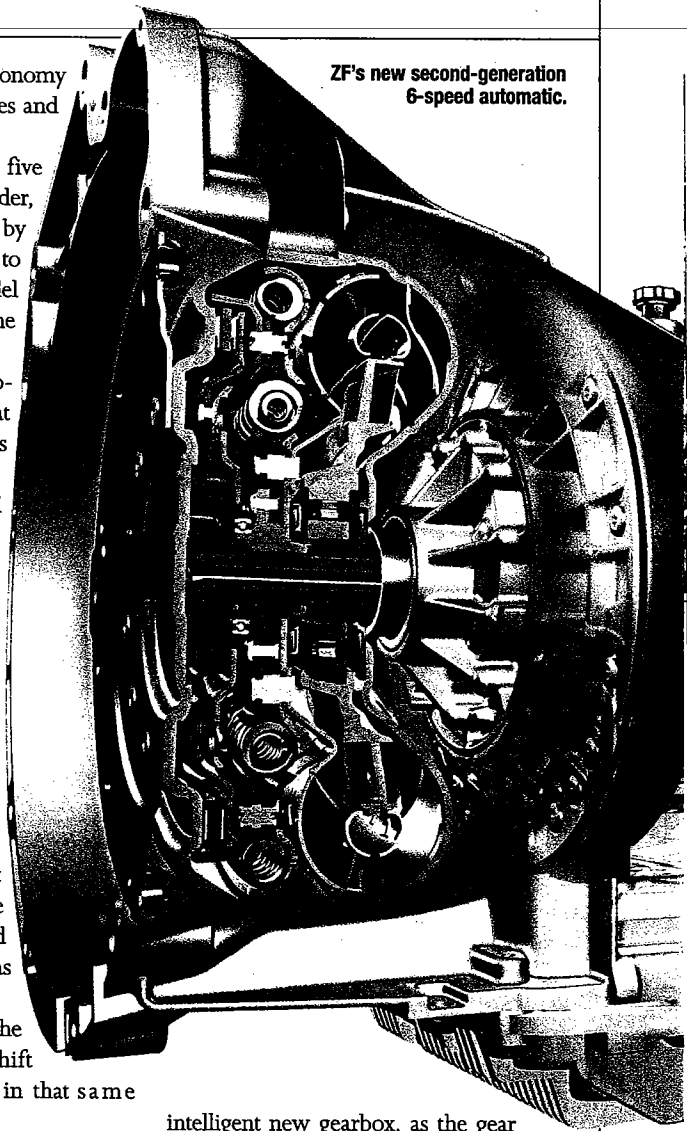
At 42 mph (68 km/h), the new transmission can shift from sixth to second gear in that same 200 milliseconds, ZF says.

There are three ways to drive ZF's new 6-speed auto in the BMWs. In normal drive mode, it functions like a normal automatic with little to distinguish it from others in the marketplace.

Move the gear shifter to the left, and the transmission is in "drive sport" mode. A "DS" symbol appears in the instrument clusters.

That is all the driver must do to fully enjoy the capabilities of this extremely

ZF's new second-generation 6-speed automatic.



intelligent new gearbox, as the gear changes now will come a bit later in the rev range. Generally, there is a 500-rpm difference between normal automatic and drive sport mode.

The control algorithms take over and will manually shift gears on your behalf to optimize engine performance. The harder the car is driven, the longer the gears are held before upshifting.

Still, there is no harshness in the gear changes, which are governed by ZF's

Adaptive Shift Strategy (ASIS) to decide the optimum gear based on load conditions, driving situation and vehicle speed.

Suffice to say the shift strategy is infinitely variable. The transmission, unlike the driver, is smart enough to know the precise moment when the next gearshift should come, based on the driver's inputs.

In automatic sport mode, under wide open throttle, the new transmission allows the engine to redline from time to time.

The third option for shifting this new transmission is to do so manually by bipping the gearshift lever forward or back, without having to fuss with a clutch pedal.

The 3-Series coupe also offers paddle shifters on the steering wheel, which work quite nicely. This system allows the driver to smack the redline with every



BMW 335i sports ZF's second-generation 6-speed automatic.

afforded by the new ZF 6-speed.

Choosing a favorite of the three driving modes is purely up to the driver, but the two sport modes (automatic or manual) clearly will push the buttons of driving enthusiasts, as delivery of torque to the wheels is almost instantaneous.

For fuel economy purposes, the manual shift mode may be less than optimal.

But even after a day of hard driving in all three modes, the trip computer on the BMW 335i reported 22.6 mpg (10.4 L/100 km) – not too shabby for a 300-hp twin-turbo 3L I-6 (which, incidentally, recently won a *Ward's* 10 Best Engines award for 2007).

The V-8-powered X5 was less impressive on the fuel-economy front, delivering 14.5 mpg (16.2 L/100 km), according to the vehicle computer.

ZF has plenty to be proud of with its new second-generation 6-speed automatic.

The company worked hard to devise a transmission that satisfied American infatuation with 0-60 mph (97 km/h) times while appealing to Europeans who love high-speed cruising. Paul Olexa, vice president-driveline sales and marketing for ZF in North America, says.

Olexa isn't giving hints about the next application for the new 6-speed automatic, except to say "others will follow."

He says the new transmission is easily tunable to match the desired "feel" of a particular brand.

Olexa is hoping vehicles that currently employ ZF's first-generation 6-speed will upgrade to the new unit when those models are refreshed.

These include the Audi A4, A6, A8 and Q7; Aston Martin DB9; most BMWs; Jaguar XJ, XK, and S-Type; Land Rover Discovery, Range Rover and Range Rover Sport; Lincoln Navigator; Rolls Royce Phantom; and Volkswagen Phaeton.

Since 2001, ZF has produced 2.8 million 6-speed automatics at its plant in Saarbruecken, Germany, including about 900,000 in 2005. ZF says it is phasing out production of 5-speed automatics.

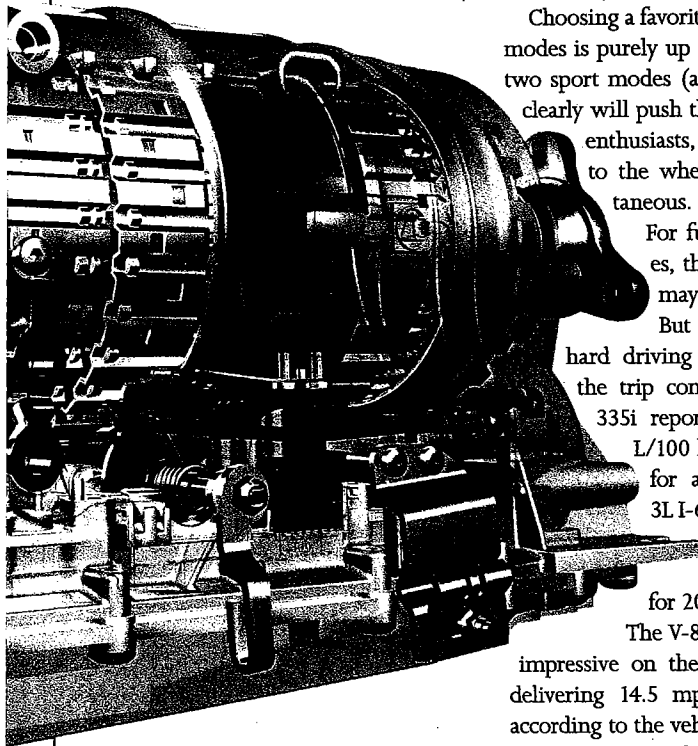
ZF also has a manufacturing angle with its new 6-speed. It is suited for production in any plant currently tooled to make automatic transmissions, with minimal new investment.

BorgWarner's DCT is best suited to be manufactured in manual-transmission plants.

Although BorgWarner is a competitor, Olexa thinks highly of the DCT.

"The DCT has raised the level of expectations for shift dynamics, and we've brought that level now to conventional automatics," he says.

But ZF also is developing its own DCT, with an emphasis on rear-wheel-drive vehicle architectures with north-south engine orientations. Look for it in the 2009 timeframe, Olexa says. ■



single gearshift, if so desired.

On winding roads through the Arizona desert, the ZF gearbox shows its stuff. With every throttle input, the driver is an active and willing participant in each gearshift event as the engine and transmission work in tandem, eager to please.

Even the porky BMW X5 4.8i (before it was knocked out of commission during the ride-and-drive by spewing power steering fluid) benefits greatly and feels more nimble due to the crisp shifting