CVT - Continuously Variable Transmission

By Aaron Gold, About.com

A continuously variable transmission, or CVT, is a type of automatic transmission that provides more useable power, better fuel economy and a smoother driving experience than a traditional automatic.

Driving a car with a CVT

The controls for a CVT are the same as an automatic: No clutch pedal and a P-R-N-D-L-style shift pattern. But while an automatic transmission has a set number of gear ratios (a.k.a. speeds), usually 4, 5 or 6, the CVT can constantly change the relationship of engine speed to car speed. When driving a car with a CVT, you never hear or feel the transmission shift -- it simply raises and lowers the engine speed as needed, calling up higher engine speeds (or RPMs) for better acceleration and lower RPMs for better fuel economy while cruising.

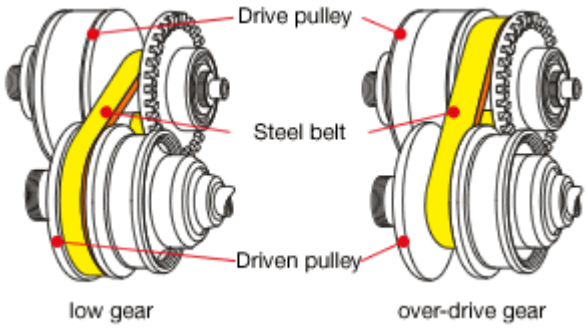
Many people find the CVT disconcerting at first because of the way cars with CVTs sound. When you step on the accelerator, the engine races as it would with a slipping clutch or a failing automatic transmission. This is normal -- the CVT is adjusting the engine speed to provide optimal power for acceleration.

Cutaway of Audi's CVT showing the variable-diameter pulleys that replace the conventional gearset

Image © Audi

How it works

Traditional transmissions use a gearset that provides a given number of ratios (or speeds). The transmission (or the driver) shifts gears to provide the most appropriate ratio for a given situation: Lowest gears for starting out, middle gears for acceleration and passing, and higher gears for fuel-efficient cruising.



CVT Assembly

Though there are several types of CVTs, most cars use a pair of variable-diameter pulleys, each shaped like a pair of opposing cones, with a metal belt or chain running between them. One pulley is connected to the engine (input shaft), the other to the drive wheels (output shaft). The halves of each pulley are moveable; as the pulley halves come closer together the belt is forced to ride higher on the pulley, effectively making the pulley's diameter larger. Changing the diameter of the pulleys varies the transmission's ratio (the number of times the output shaft revolves for revolution of the engine), in the same way that a 10-speed bike routes the chain over larger or smaller gears to change the ratio. Making the input pulley smaller and the output pulley larger gives a low ratio (a large number of engine revolutions producing a small number of output revolutions) for better low-speed acceleration. As the car accelerates, the pulleys vary their diameter to lower the engine speed as car speed rises. This is the same thing a conventional automatic or manual transmission does, but while a conventional transmission changes the ratio in stages by shifting gears, the CVT continuously varies the ratio -- hence the name "continuously variable transmission".

Advantages of the CVT

Engines do not develop constant power at all speeds; they have specific speeds where torque (pulling power), horsepower (speed power) and fuel efficiency are at their highest levels. Because there are no gears to tie a given road speed directly to a given engine speed, the CVT can vary the engine speed as needed to access maximum power as well as maximum fuel efficiency. This allows the CVT to provide quicker acceleration than a conventional automatic or manual transmission while delivering superior fuel economy.

Disadvantages of the CVT

The CVT's biggest problem has been user acceptance. Because the CVT allows the engine to rev at any speed, the noises coming from under the hood sound odd to ears accustomed to conventional manual and automatic transmissions. The gradual changes in engine note sound like a sliding transmission or a slipping clutch -- signs of trouble with a conventional transmission, but perfectly normal for a CVT. Flooring an automatic car brings a lurch and a sudden burst of power, whereas CVTs provide a smooth, rapid increase to maximum power. To some drivers this makes the car feel slower, when in fact a CVT will generally out-accelerate an automatic.

Automakers have gone to great lengths to make the CVT feel more like a conventional transmission. Most CVTs are set up to creep forward when the driver takes his or her foot off the brake. This provides a similar feel to a conventional automatic, and serves as an indicator that the car is in gear. Other CVTs offer a "manual" mode that simulates manual gear changes.

Because early automotive CVTs were limited as to how much horsepower they could handle, there has been some concern about the long-term reliability of the CVT. Advanced technology has made the CVT much more robust. Nissan has more than a million CVTs in service around the world and uses them in powerful cars such as the 255 horsepower Maxima, and says their long-term reliability is comparable to conventional transmissions.

History of the CVT

Leonardo DaVinci sketched the first CVT in 1490. Dutch automaker DAF first started using CVTs in their cars in the late 1950s; however technology limitations made CVTs unsuitable for engines with more than around 100 horsepower. In the late 80s and early 90s, Subaru offered a CVT in their Justy mini-car, while Honda used one in the high-mileage Honda Civic HX of the late 90s.

Improved CVTs capable of handling more powerful engines were developed in the late 90s and 2000s, and CVTs can now be found in cars from Nissan, Audi, Honda, Ford, GM, and other automakers.