Variable Torque Management VTM-4 Explanation

By Gary Flint - American Honda

Variable Torque Management 4-Wheel Drive (VTM-4)
After studying various all-wheel- and four-wheel-drive systems offered by the wide variety of pickups on the market today, Ridgeline engineers concluded that virtually every one had functional shortcomings and was undesirably bulky and heavy. The direct result of that research was to use Honda's innovative fully automatic VTM-4 system. This fully automatic 4WD system is the best match for the Ridgeline owner and proactively distributes torque to all four wheels as needed. This system provides front-wheel drive for dry-pavement cruising conditions and engages all-wheel drive when needed to improve stability or maneuverability. Unlike many competitive systems that use an engagement strategy triggered by wheel slippage, the Ridgeline's VTM-4 system anticipates the need for all-wheel drive and engages the rear wheels before slippage begins. Additional torque is redistributed to the rear for improved performance during acceleration, especially on low friction surfaces and during towing. In addition, the VSA system provides a limited-slip differential effect by applying braking force to a slipping front wheel thereby directing driving force to the wheel with more grip.

Another special feature is a "VTM-4" lock button, located on the instrument panel, which temporarily holds engagement of both rear wheels to aid traction

VTM-4 Modes of Operation
1. Acceleration Mode
There are three distinct modes of VTM-4 engagement. The first – called the acceleration torque control (ATC) mode – is unique to this system. It works even on dry pavement to proactively distribute driving torque to all four wheels as the Ridgeline accelerates from a stop to cruising speed. One notable benefit of this mode is that traction is immediately available to move the vehicle from rest through a slippery intersection before slippage occurs. (Once a wheel slips, the traction available for forward propulsion and lateral restraint is significantly diminished.)

A second advantage is that apportioning drive torque among all four wheels greatly diminishes the likelihood of torque steer. Handling dynamics are also improved. Reducing the propulsive force carried by the front tires leaves more adhesion for steering the vehicle into a tight bend or for holding cornering arc in the middle of a turn. In other words, the Ridgeline's dynamic balance is greatly enhanced by ATC logic.

Rear wheel torque rises smoothly from zero to the optimum setting in proportion to vehicle acceleration (both forward and reverse). At higher speeds, the front wheels are capable of providing the desired thrust with excellent handling so torque delivered to the rear wheels automatically diminishes with speed. While cruising, all driving torque is delivered by the front wheels in the interests of smoothness, quietness, and fuel efficiency.

2. Slip Control Logic
The second engagement mode uses wheel slippage control logic. If the difference in rotational speed between front and rear wheels rises because of a slippery surface or poor traction at the front of the vehicle, that condition is detected by wheel-speed sensors which are monitored by VTM-4's ECU. In response, the ECU commands an increasing amount of torque for the rear wheels. Torque is proportional to both slip rate and the rate at which the slip rate is increasing.

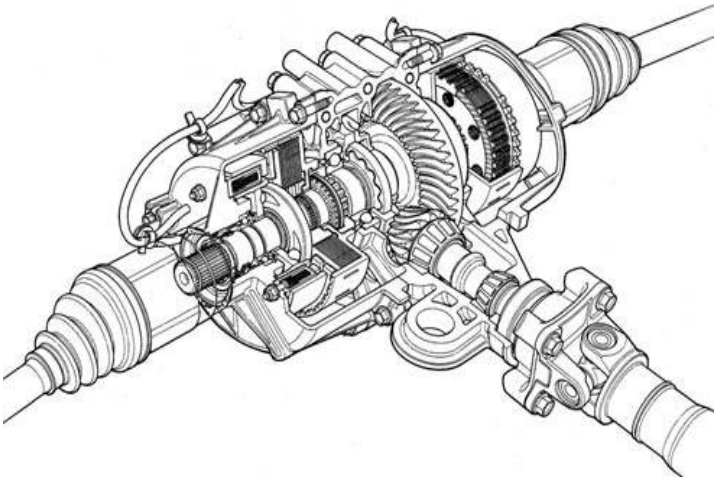
This operation is similar to conventional slip-based all-wheel-drive systems already on the market.

3. VTM-4 Lock Mode

The third mode of all-wheel-drive engagement activates when the driver presses the lock button mounted on the instrument panel. The maximum amount of rear-drive torque is locked in until the vehicle gets moving and exceeds six mph, at which time rear drive torque is gradually diminished. By 18 mph, the lock mode is fully disengaged. When vehicle speed drops below 18 mph, the lock mode automatically reengages. The shift lever must be in the first, second, or reverse-gear position to use the lock mode.

The maximum torque delivered to the rear wheels allows the Ridgeline to claw up a 28-degree (53-percent slope) dirt grade. On a split-mu (split-friction) grade (different amounts of traction at each wheel), VTM-4 automatically provides sufficient rear-wheel torque to help the vehicle climb steep and slippery terrain such as a steep driveway with patches of snow and ice.

Rear Differential Structure



The Ridgeline's rear axle unit does not use a conventional differential. Instead, a hypoid ring-and-pinion gear set supported by a cast-aluminum housing switches torque from the propeller shaft's longitudinal orientation to the lateral orientation necessary to drive the rear wheels.

A connection from the ring gear to each wheel's half-shaft is made by left- and right-side clutches. Each drive clutch consists of three elements: an electromagnetic coil, a ball-cam device, and a set of 19 wet clutch plates which are similar in design to clutches used in an automatic transmission. Ten of the plates are splined (mechanically connected) to the ring gear while nine of the plates are splined to a half shaft. Left and right clutches are identical.

The VTM-4 system's electronic control unit (ECU) determines torque which is to be distributed to the rear wheels, then electric current is sent to the two electromagnetic coils. The resulting magnetic field moves a rotating steel plate toward each fixed coil. Friction between that steel plate and an adjoining cam plate causes the cam plate to begin turning. As it does, three balls per clutch roll up curved ramps, creating an axial thrust against a clutch-engagement plate. This thrust force compresses the wet clutch plates, thereby engaging drive to the corresponding rear wheel.