



Understanding Ford's F-Series VSS Systems

The ATRA HelpLine is constantly receiving calls related to the vehicle speed sensor (VSS) system on Ford's F-series trucks. Most of these questions are fairly common, ranging from the basic system operation to step-by-step diagnostic routines.

One of the most common questions asked is, "how does the VSS system work?" To address this, we're going to start by examining the early 1989-91 F-series VSS system, then concentrate on the later 1992-98 F-series system (which seems to create the most confusion), and then briefly discuss the newer 99-and-later VSS system changes. Our goal for this issue will be to help you understand how the VSS system works.

The purpose of the VSS system is to inform the computer how fast the vehicle is moving. All of the Ford trucks we're going to look at use a permanent magnet, AC-generating sensor, also called a *variable reluctance sensor*.

How the AC VSS Works

The permanent magnet AC sensor consists of two basic components: the speed sensor itself and a trigger wheel (figure 1). *Trigger wheel* is a generic term: Automakers also refer to this as a toothed wheel, exciter ring, reluctor or tone ring, just to name a few. No matter what they call it, the trigger wheel's basic job is to trigger the speed sensor.

The speed sensor is a permanent magnet with a soft iron core, wrapped with a coil of fine wire. It's usually mounted on the transmission or differential housing. The trigger wheel is

usually mounted on the output shaft of the transmission or the rear differential carrier assembly.

When the output shaft or differential carrier rotates, the trigger wheel's teeth move past the sensor. As a tooth moves toward the sensor, the magnetic field surrounding the sensor coils gets stronger. As the tooth moves away from the sensor, the magnetic field weakens. This constant buildup and collapse of the magnetic field induces an AC signal at the sensor terminals.

This AC signal can be measured in AC volts and frequency. The frequency is determined by how many times per second the sensor is cycled or triggered between positive and negative.

Measuring Variable Frequency Signals

Frequency is measured in hertz (Hz), which means *cycles per second*. The best way to measure the VSS or DSS signal is with a graphing meter or oscilloscope. The graphing meter or oscilloscope will display the actual waveform being produced, so you can look for any irregularities in the signal. Any irregular pattern in the waveform may indicate electromagnetic interference (noise) in the VSS system, or a problem in the wiring or sensor itself.

You can also use a digital multimeter (DMM) capable of checking frequency to measure the signal voltage and frequency.

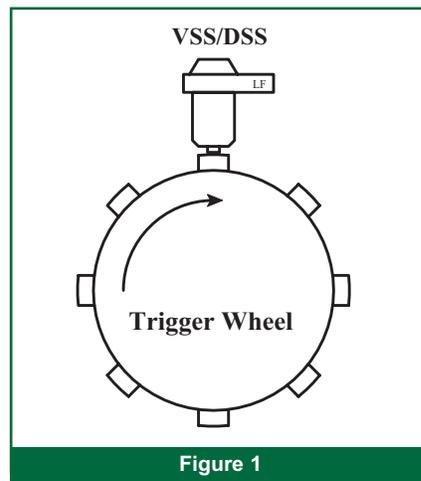


Figure 1

On an AC, permanent magnet sensor, both AC voltage and frequency increase with the speed of the trigger wheel. The AC voltage should range from 0 volts at 0 MPH to 3.5 volts at 30 MPH. Frequency should increase from 0 Hz at 0 MPH to about 125 Hz at 55 MPH.

AC-DC Signal Conversion

Permanent magnet AC sensors produce an AC signal, which then goes to the various systems that require a vehicle speed signal. But the computer is unable to read this raw AC signal, so it must first convert the signal to a readable digital signal.

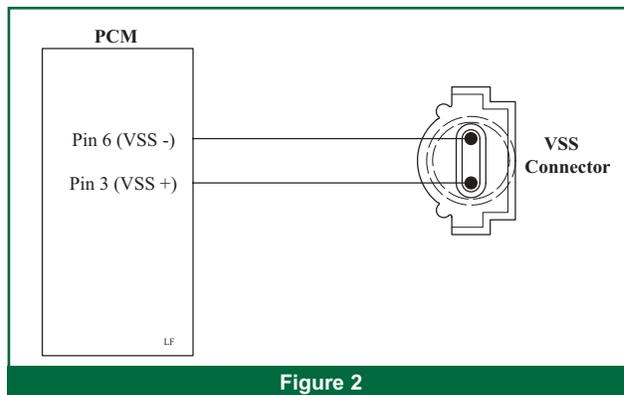


Figure 2

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On the 1989-91 Ford trucks, the AC converter is built into the PCM itself. But on later units, the VSS signal first passes through a device called a *buffer* or *interpreter*, commonly referred to as a *DRAC* or *speed buffer* on GM vehicles. On Ford vehicles, this buffer is usually located in the component receiving the VSS signal. However, the 92-96 Ford F-series trucks use a PSOM (programmable speedometer) odometer module to convert the raw AC signal to digital before delivering it to the PCM and cruise control system.

1989-91 Vehicle Speed Sensors

The 89-91 Ford F-series truck uses a very basic VSS system. The VSS sensor is located on the side of the transmission or transfer case. This system consists of a VSS sensor, system wiring, and the Powertrain Control Module (PCM). On these early units, the VSS signal goes directly to the PCM; the AC converter is built into the PCM itself.

This early system had very few problems and was easy to diagnose. All you really needed to do was check for an AC signal between terminals 3 and 6 at the PCM, with the wheels turning (figure 2). If you had a VSS signal at the PCM, any VSS codes or problems were probably due to a problem in the PCM. If you didn't have a VSS signal at the PCM, you either had a wiring or sensor problem.

1992-96 VSS Changes

The 92-96 Ford F-series trucks introduced several changes to its VSS system. In 1992, Ford incorporated a programmable speedometer (PSOM) and a Rear Antilock Brake System (RABS) in the F-series truck (figure 3). The PSOM took the place of the original speedometer cluster. With the introduction of the Rear Antilock Brake System, Ford moved the VSS from the side of the transmission to the top of the rear differential housing. Ford then changed the name of the VSS to DSS (differential speed sensor) and incorporated it into the RABS system.

The introduction of the PSOM and RABS systems into the F-series truck changed the way the VSS communicat-

ed with the PCM. The VSS signal is now produced by the DSS in the differential. The RABS module and PSOM share the VSS signal before it goes to the PCM and cruise control system. This basic change in the way the PCM receives its vehicle speed signal is what confuses most people.

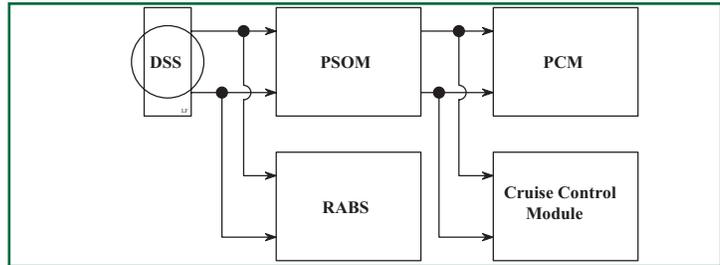


Figure 3

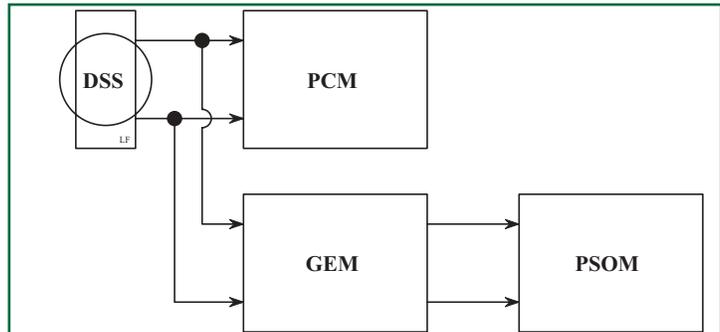


Figure 4

1997-98 VSS Circuit Changes Again

Beginning with the 97 F-series truck, Ford changed the VSS signal routing again. The VSS signal now goes directly to the PCM and GEM modules from the VSS/DSS sensor (figure 4). The GEM module sends the VSS signal to the PSOM. The PSOM is no longer responsible for providing the VSS signal to the PCM and cruise control system.

1999-On VSS Eliminated Entirely

In 1999, Ford introduced another change to the VSS system. Starting in 1999, Ford eliminated the VSS sensor as we know it. The vehicle speed signal is now produced by the Antilock Brake System (ABS), using wheel speed sen-

sors on both front wheels and the differential. These sensors provide the ABS system with the needed wheel speed information. The ABS module takes the wheel speed sensor information and calculates the proper vehicle speed signal before it distributes it on a shared line to the PCM, speed control and GEM modules (figure 5). The GEM module then sends the signal to the instrument cluster for speedometer operation.

As you can see, Ford has made some significant changes to its VSS system over the past few years. But don't worry; the diagnostic routines are very similar, once you understand how the systems operate. We'll examine the diagnostic procedures for these VSS systems in the next issue of *GEARS*.

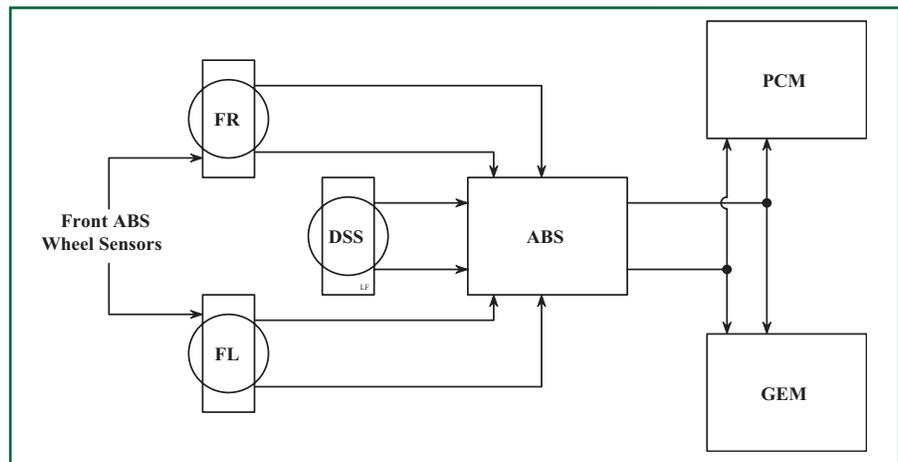


Figure 5