Transmission Swaps: How to Handle VSS vs OSS Signals
Rev 1.0

There is a big difference between how vehicle speed signals are handled between 94-98 Mustangs and 99-04 Mustangs. The 94-98 Mustangs have an output-shaft gear-driven VSS (Vehicle Speed Sensor) while the 99-04 Mustangs have use an output shaft reluctor wheel/magnetic sensor called an OSS (Output Shaft Sensor). (Strictly speaking, there is also a reluctor wheel and a magnetic sensor inside of the older VSS sensor, but the signal timing is very different between the two generations.)

The VSS is on the left and the OSS is on the right.

VSS Signals
The VSS signal in the older cars goes to the PCM, the speedometer, odometer and the cruise control unit. Those units all expect an 8000 pulse per mile signal. Changes in tire size and axle ratios will throw that signal rate off. For proper operation, the signal must be corrected with new speedometer gears, and or an electronic signal recalibrator such as a Dallas Mustang Speedcal or an FRPP Recalibrator. We have written a VSS calculator that will calculate the VSS error introduced by your tire size and axle ratio changes, and lets you do what-ifs to see how close you can get to 8000 pulses per mile with different speedometer gear selections. Should you want to use a Speedcal or Recalibrator, you can enter your new, erroneous VSS rate into our Speedcal/Recalibrator Calculator to get the switch settings that will cause your Speedcal or Recalibrator to generate the correct 8000 pulse per mile VSS signal.

We have characterized the VSS signal and documented it here: https://img1.wsimg.com/blobby/go/1975f84f-4935-4131-8404-5a914da1afb7/downloads/1brkbpupo_164823.pdf

OSS Signals
The OSS signal in the newer cars goes only to the PCM, where the vehicle speed is calculated. The calculated vehicle speed is then sent via a data communications bus to the instrument cluster and the cruise control system for use by their respective microcontrollers. The Tire Revs per Mile, the Axle Ratio and the Number of Holes for OSS Sensor (number of teeth in the tailshaft reluctor wheel) are entered into the PCM's tune. With that information, the PCM can calculate the proper vehicle speed for whatever components that are used.

It is interesting to note that, given a stock tire size with 815 revs per mile and a 3.27 axle ratio and 12 holes for OSS Sensor, the manual transmission OSS signal is 32000 pulses per mile, 4 times the rate of the standard VSS signal in the older cars.

Some typical reluctor wheel tooth counts for popular transmissions (Thanks to Ryan @ SCT):

Transmission	OSS Reluctor Wheel Tooth Count
Most T45/T56/3650's	12
Most 4R70's	6
Most 4R75's	24
4R100	18

Per SPeace-ATL on Corral, all TR3650 transmissions are OSS transmissions.

Swapping a 99-04 OSS transmission into a 94-98 car
Since the PCM, speedometer, odometer and cruise control units all expect an 8000 pulse per mile signal, you must convert the OSS signal rate that is fixed by your tire size, axle ratio and OSS reluctor wheel to an 8000 pulse per mile rate. This must be done with an extended range Speedcal.

To calculate your OSS signal rate, multiply the tire revs per mile by the axle ratio to get the output shaft revs per mile. Then you multiply that by the number of teeth on your transmission OSS reluctor wheel.

OSS Signal Rate = Tire Revs/Mile * Axle Ratio * OSS Reluctor Wheel Tooth Count

For example, with an 03 Cobra T56 in a 96 Cobra with stock tire size and a stock 3.27 axle ratio, you would multiply 815 tire revs per mile times 3.27 axle ratio to get 2665.05 ouput shaft revs per mile. Then you mulitply that by 12 teeth on the T56 reluctor wheel to get 31980.6 OSS pulses per mile.
At this point, you know your new "VSS' rate and you enter that into the "Current Setup VSS Pulses per Mile" box in the Speedcal/Recalibrator Calculator to get the Extended range Speedcal setting of 1000000000.

If you have a non-stock tire size you can calculate your tire revs per mile any online tire size calculator you like.

A word of warning about on-line tire calculators, however. Some calculators, such as Discount Tire Direct Tire Calculator will give you the tire revs per mile of a tire that is not mounted on a vehicle. When you mount a tire on a vehicle, the weight of the vehicle will cause it to compress a bit, which reduces the diameter of the tire a bit. I recommend this calculator, which seems to try to compensate for the effective diameter of a tire when loaded by the vehicle weight: http://www.1010tires.com/TireSizeCalculator.asp
Another example is if you put an 03 Cobra T56 in a 98 Cobra with 315/35/17 tires and a 4.10 axle ratio. From the tire calculator above we see that the tire revs per mile are 785.33. 785.33*4.10=3219.853. 3219.853*12=38638.236. If you enter that into the "Current Setup VSS Pulses per Mile" box in the Speedcal/ Recalibrator Calculator you get the Extended range Speedcal setting of 1001101010.

Swapping an older transmission into a 99-04 car
Since the PCM in the newer cars can calculate the Speed from an OSS signal, the trick is to select the proper tire revs per mile, axle ratio and Number of Holes for OSS Sensor values to cause the PCM to calculate the proper speed from the VSS signal.

Selecting the Number of Holes for OSS Sensor value
The biggest challenge with this swap is the fact that the VSS signal will not be an integral number of pulses per rev of the transmission output shaft due to the speedometer gears used to drive the VSS signal. All Mustang VSS's use an 8 tooth reluctor wheel inside of the VSS. To calculate the number of VSS pulses per output shaft rev, you use this formula:

VSS Pulses per Output Shaft Rev = 8 * (Speedo Drive Gear Teeth/Speedo Driven Gear Teeth)

The range of Speedometer Drive Gears is 6 to 8 teeth and the range of Speedometer Driven Gears is 16 to 21 teeth (with some people using a non-Ford 23 tooth gear). This gives a VSS Pulses per Output Shaft Rev range from 8*(6/23)=2.087 to 8*(8/18)=3.556.

Since we need to put an integer into the Number of Holes for OSS Sensor value in the tune, you should pick 2, 3 or 4, whichever is the closest integer to the actual VSS Pulses per Output Shaft Rev you calculate. We will compensate for the difference between the actual VSS pulses and the integer VSS pulses by tweaking the axle ratio value we put into the tune.

If you don't know your speedometer drive and driven teeth counts, but you do know the VSS was accurate in a donor car with a known axle ratio, you can use any speedometer gear combination for that axle ratio from the gear table on the VSS Calculator page.

For our example, we will assume we are swapping a T45 from an older GT into a 99-04 car with a 3.73 axle ratio. The GT had a 2.73 axle ratio, and 8 tooth speedo drive gear and an 18 tooth speedo driven gear. The VSS Pulses per Output Shaft Rev = 8*(8/18)=3.556. As a result, we will select a Number of Holes for OSS Sensor value of 4 and enter it into the tune.

Calculating the Axle Ratio Value
The Axle Ratio value that gets put into the tune will need to compensate for the actual axle ratio in the 99-04 car, and the difference between the actual VSS pulses and the integer VSS pulses. the formula for calculating the Axle Ratio value is:

Axle Ratio Value = Actual Axle Ratio * (Speedo Drive Gear/Speedo Driven Gear) * 8 / Number of Holes for OSS

Continuing our example from above:

Axle Ratio Value = 3.73 * (8/18)*(8/4) = 3.31555 which we will round to 3.32 and enter into the tune.

Calculating the Tire Revs per Mile Value
The stock number of tire revs per mile for Mustang tires is 815. If you have non-standard sized tires, you can enter the tire size into a calculator on this page to get the tire revs per mile value for your rear tires:

http://www.1010tires.com/TireSizeCalculator.asp

Enter the tire revs per mile value into the tune, and you are done.

Note: As of 4/20/2010, we have had feedback that has indicated that this how-to will get you very close, but not necessarily exactly on speed. Please contact us to let us know how well this technique works or does not work for you.

The Math Behind the Axle Ratio Value Calculations

Output Shaft Revs/Mile=Tire Revs/Mile*Actual Axle Ratio

VSS Revs/Mile=OS Revs/Mile*(Drive Gear Teeth/Driven Gear Teeth)

VSS Revs/Mile=Tire Revs/Mile*Actual Axle Ratio*(Drive Gear/Driven Gear)

VSS Pulses/Mile=VSS Revs/Mile*(VSS Pulses/VSS Rev)

VSS Pulses/Mile=Tire Revs/Mile*Actual Axle Ratio*(Drive Gear/Driven Gear)*(VSS Pulses/VSS Rev)

OSS Pulses/Mile=Tire Revs/Mile*(OSS Pulses/OS Rev)*PCM Axle Ratio

Now we set the VSS Pulses/Mile=OSS Pulses/Mile and solve for PCM Axle Ratio:

Tire Revs/Mile*(OSS Pulses/OS Rev)*PCM Axle Ratio=Tire Revs/Mile*Actual Axle Ratio*(Drive Gear/Driven Gear)*(VSS Pulses/VSS Rev)

If we divide both sides of the equation by Tire Revs/Mile, that factor cancells out:

(OSS Pulses/OS Rev)*PCM Axle Ratio=Actual Axle Ratio*(Drive Gear/Driven Gear)*(VSS Pulses/VSS Rev)

If we divide both sides of the equation by (OSS Pulses/ OS Rev), we get:

PCM Axle Ratio=Actual Axle Ratio*(Drive Gear/Driven Gear)*(VSS Pulses/VSS Rev)/(OSS Pulses/OS Rev)

Since the VSS Pulses/VSS rev is always 8, we can substitute to simplify:

PCM Axle Ratio=Actual Axle Ratio*(Drive Gear/Driven Gear)*8/(OSS Pulses/OS Rev)

Note: The OSS Pulses/OS Rev is the Number of Holes for OSS Sensor value in the tune.