



## Volumetric Efficiency

*ADS Diagnostics*

### Automotive Service Solutions

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# BOSCH

- ▣ **This class is designed to:**
  - ▣ Develop the technician's skills to use their scan tool to resolve difficult technical drivability issues efficiently.
  - ▣ Demonstrate the purpose of Volumetric Efficiency testing.
  - ▣ Demonstrate diagnosing the results of the VE test by testing related components using Datastream.
  - ▣ Improve diagnostic efficiency and productivity using better test procedure.
  - ▣ This class is not about how to design an engine, it is a class of how to diagnose an engine.

- ❑ What is a Volumetric Efficiency (VE) test and why is it important?
- ❑ Volumetric Efficiency is the verification of an engines performance calculated from the amount of Air used.
- ❑ Performing a VE test can reveal the accuracy of a vehicle's Mass Airflow Sensor, more importantly it can quickly diagnose drivability issues.
- ❑ Essentially you will be able to determine the area of cause of a drivability problem much faster.
- ❑ It will help you to determine if you are dealing with a Fuel, Air, Exhaust or Mechanical issue without spending hours trying to determine the direction to start your diagnosis.
- ❑ It is the key to successfully diagnosing and fixing a vehicle efficiently making you more money.

- ❑ Have you ever run across a similar problem like the following example?
- ❑ 1999 Ford Taurus 3.4 VIN U with 95,000 miles
- ❑ There were no DTC's
- ❑ Customer complaint of intermittent MIL
- ❑ VE results, 59%
- ❑ Datastream showed STFT to be high
- ❑ Engine Mechanical issue
- ❑ Mode 6 pending issue EGR low flow
- ❑ EGR test, passage plugged, confirm Engine Mechanical

- ❑ Have you ever run across a similar problem like the following example?
- ❑ 2004 Chevrolet Impala 3.4 with 73,000 miles
- ❑ DTC P0101 MAF
- ❑ VE Test results, 62%
- ❑ Datastream STFT normal
- ❑ Exhaust Restriction
- ❑ Performed Catalyst, confirm Exhaust Restriction

## Volumetric Efficiency Calculator

Road Test

[OTCtools.com/ve](http://OTCtools.com/ve)

## Diagnosing Low VE

### Mechanical Engine Diagnostics

MAP Sensor Test

### MAF Diagnostics

MAF Test

### Fuel Systems Diagnostics

Fuel Trim

H02S Test

AFR Sensor Test

### Intake Air Restriction

MAF Test

### Exhaust Restriction

Catalyst Tests



## Volumetric Efficiency Road Test Calculator



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- ▣ There are a few things you will need to do first to perform a Volumetric Efficiency Test.
  - ▣ Find a good road test area.
    - ▣ Safe from pedestrians and other vehicles.
    - ▣ Where you can perform a WOT road test.
  
- ▣ The second requirement is to set up your Bosch scan tool.
  - ▣ Datastream
    - ▣ MAF – Mass Air Flow – g/s
    - ▣ IAT – Intake Air Temperature - °F
    - ▣ RPM
  
- ▣ When IAT reads in °C, the PID will have to be converted. Converting °C to °F: **(°C x 1.8) + 32 = °F**
  
- ▣ The engine must be at operating temperature.
  
  
- ▣ VE Specification 75% to 90%



[www.OTCtools.com/ve](http://www.OTCtools.com/ve)



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# Diagnosing Low VE



## VE Diagnostics

### Engine Mechanical

- ▣ VE very low
- ▣ STFT high
  - ▣ Low compression - engine mechanical
    - ▣ Valve seating
    - ▣ Burnt valves
    - ▣ Piston rings
    - ▣ Cam timing
    - ▣ Cam lobes
      - ▣ Adding fuel because the PCM may think the engine is under a load due to lower than normal vacuum.
- ▣ VE is a calculation of the amount of air going in and with low compression the engine will not be able to create a sufficient low pressure area behind the throttle plate for the atmospheric high pressure to overcome.
- ▣ Perform the following test for verification.
  - ▣ MAP



# MAP Sensor Test

- ❑ KOEO the MAP Sensor should read approximately 4.6 volts at atmospheric pressure approximately 14.7 PSI
- ❑ KOER, idle and operating temperature the MAP Sensor reading should be between 1 to 2 volts
- ❑ Slowly increase the RPM as you increase RPM MAP voltage should drop then rise back to normal levels



# VE Diagnostics

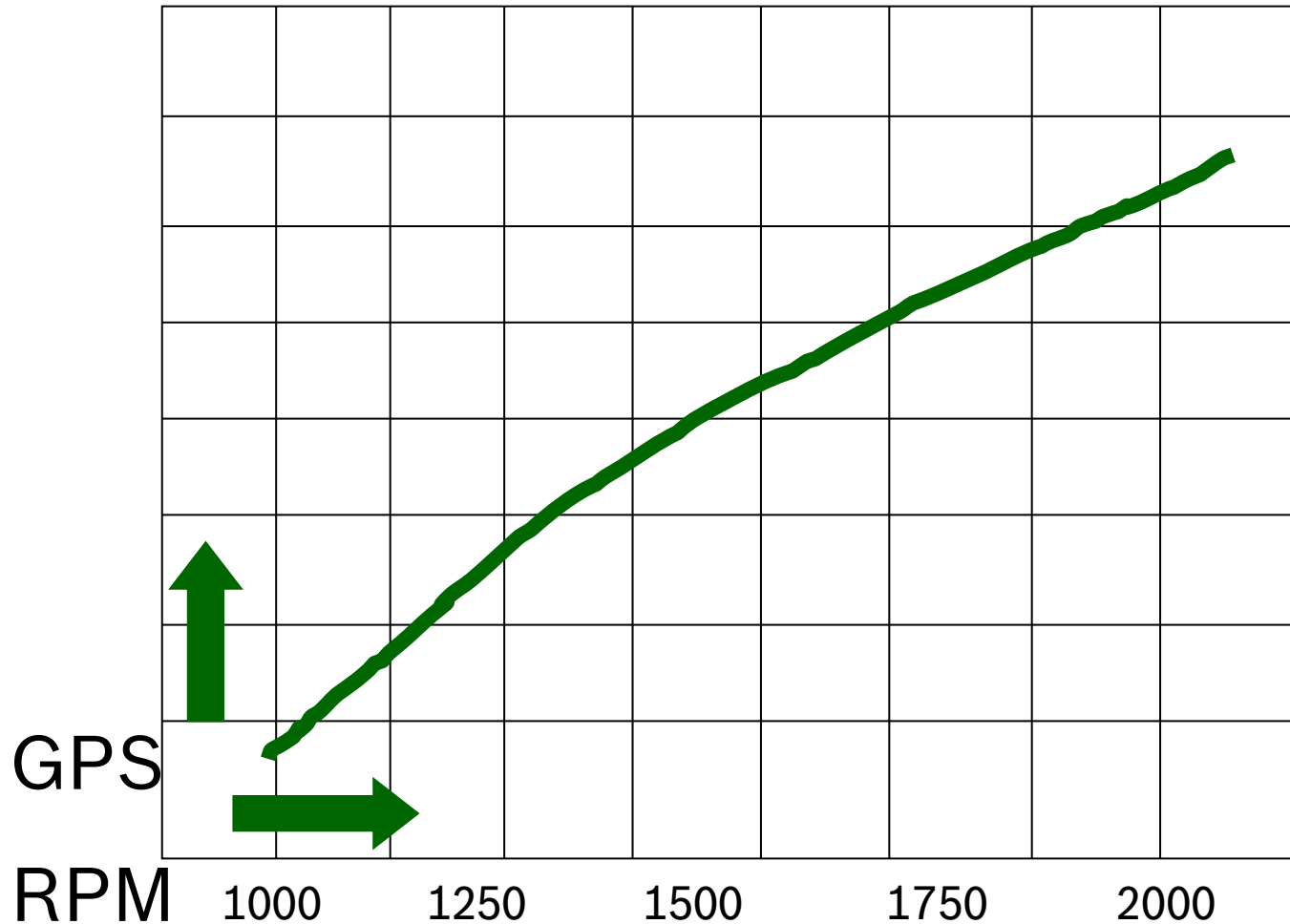
## MAF

- ▣ VE low
- ▣ MAF low
- ▣ STFT high
  - ▣ MAF is not accurately reporting air volume. This may require cleaning the MAF hot wire, sensing wire or vane.
  - ▣ It could also be a result of additional air entering after the MAF in the air stream as a result of a leak in the snorkel.
- ▣ MAF measures the volume of air being consumed. If MAF readings are reporting low g/s to the PCM your AVF – Actual Volumetric Flow Rate calculation will be inaccurate. Inaccurate MAF readings will result with PCM correcting IPW for a lean condition.
- ▣ Perform the following test for verification.
  - ▣ MAF

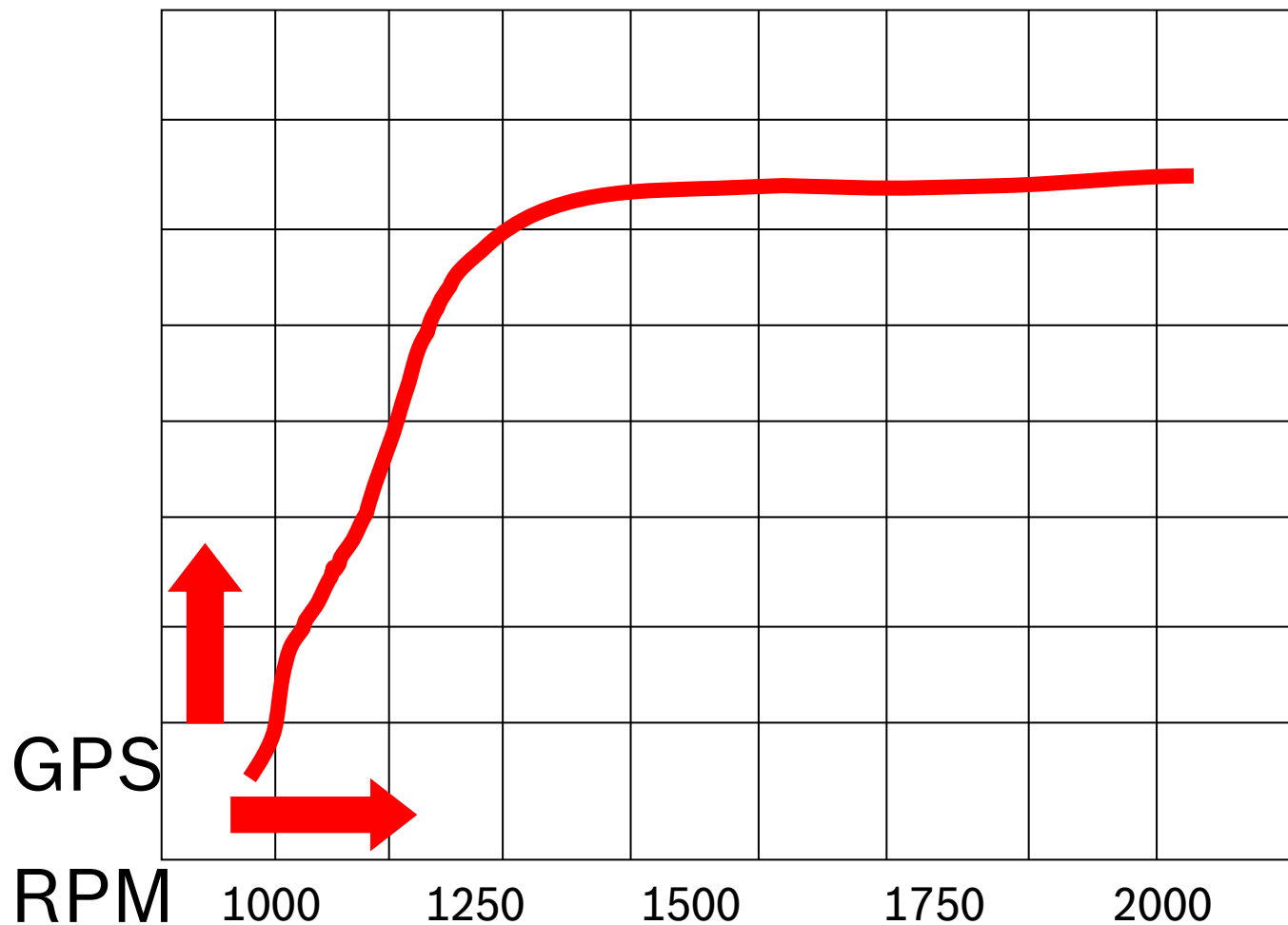
# *MAF Test*

- ▣ KOER, Engine At Operating Temperature
- ▣ Scan Tool Datastream
  - ▣ MAF GPS
    - ▣ (Frequency or volts may be substituted for GPS)
- ▣ Mark Points Of MAF GPS On Graph Paper
  - ▣ 1000 Rpm
  - ▣ 1250 Rpm
  - ▣ 1500 Rpm
  - ▣ 1750 Rpm
  - ▣ 2000 Rpm
- ▣ Connect Plot Points, Graph Line Should Rise Smooth

## Good MAF Graph

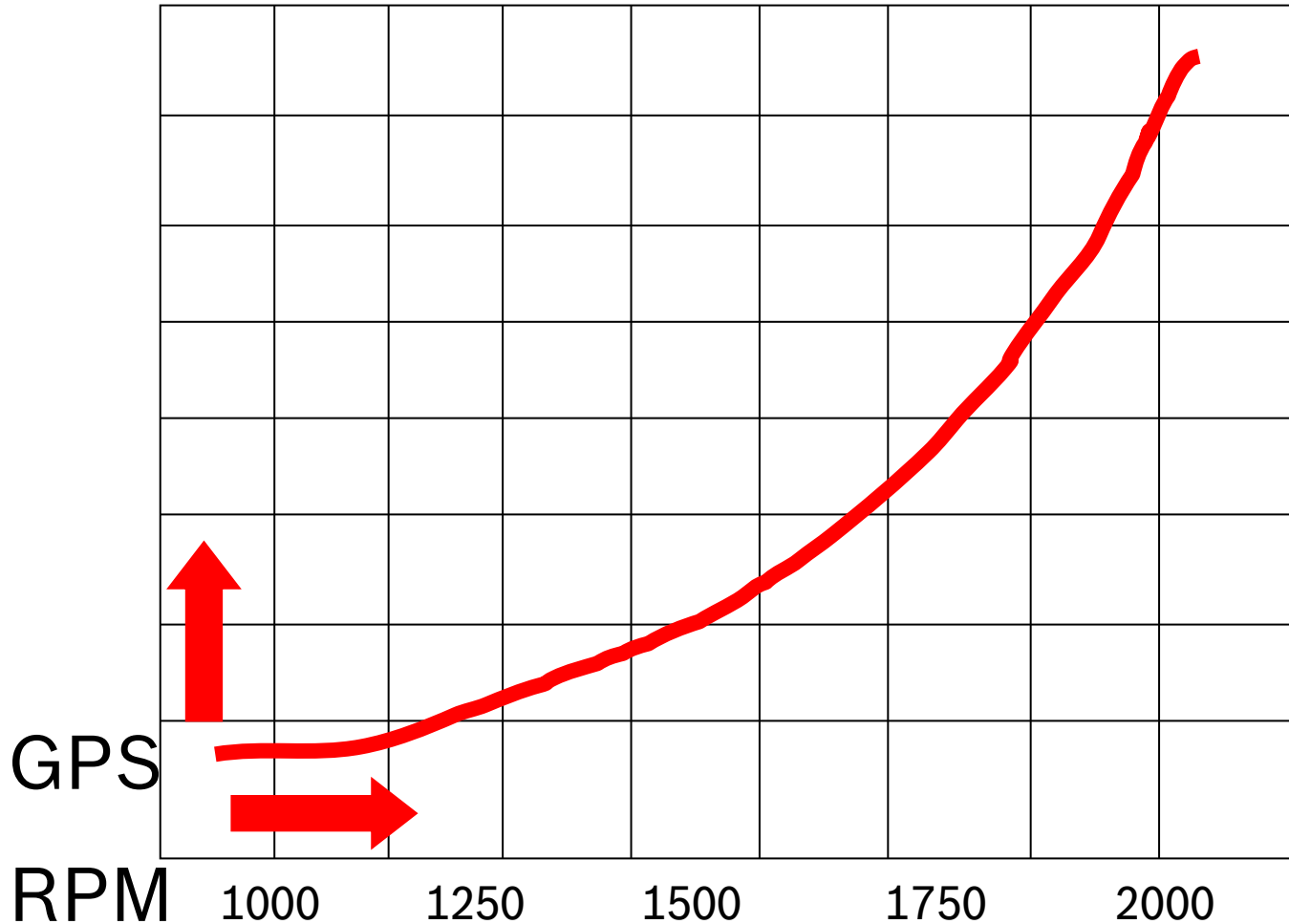


## *Bad MAF Graph - Out of Calibration*





## *Bad MAF Graph - Air Leak*



# VE Diagnostics

## Fuel System

- ▣ VE low
- ▣ STFT high
- ▣ HO2S or AFR lean
  - ▣ Dirty fuel filter
  - ▣ Low fuel pump pressure
  - ▣ Low fuel pump volume
  - ▣ Restricted injector flow.
- ▣ If the engine does not have enough fuel to add to the combustion chamber, power will be limited resulting in the pressure behind the throttle plates being lower than required. As a result, air volume during wide open throttle will be low. The HO2S or AFR sensor will report a lean condition at idle as a result of the low fuel volume and the PCM will compensate with adding fuel commanding plus number for Fuel Trim.
  
- ▣ Perform the following test for verification:
  - ▣ Fuel Trim
  - ▣ HO2S
  - ▣ AFR



## Fuel Trim Diagnostics

<b>Idle</b>	<b>2500 RPM</b>	<b>Possible Causes</b>
+ 5% and Up	0%	Vacuum Leaks
0%	+ 5% and Up	Low Fuel Volume
+ 5% and Up	+ 5% and Up	Low Fuel Pressure
-5% and lower	0%	Contaminated Crankcase
-5% and lower	-5% and lower	Injectors

# *H02S Test*

- ❑ Graph HO2S Bank 1 Sensor 1
- ❑ Specification for Good O2 Sensor: 10 cycles from 200mv Lean to 800mv Rich and then Rich to Lean in 1 second, at 2000 RPM hot engine
- ❑ Datastream should display a minimum of four O2 Sensor cycles from 200mv Lean to 800mv Rich and then Rich to Lean, at 2000 RPM hot engine

## AFR Sensor Test

- ▣ Engine at operating temperature
- ▣ No DTC's present for AFR or AFR Heater circuit
- ▣ From idle raise engine to 2500 RPM
- ▣ AFR should read 3.30 volts
- ▣ Snap the throttle to 4000 RPM
  - ▣ AFR voltage will fall Rich

OEM PID	Global OBDII PID	Amperage
2.50 Volts	0.50 Volts	Positive

- ▣ After throttle is closed and at return to idle
  - ▣ AFR voltage should rise Lean

OEM PID	Global OBDII PID	Amperage
3.80 Volts	0.78 Volts	Negative

- ▣ If no change check AFR heater circuit
- ▣ Always verify AFR specification with Identifix

# VE Diagnostics

## Intake Restriction

- ▣ VE low
- ▣ STFT normal
- ▣ The intake restriction could be a result of a dirty air filter, an animals' nest in the snorkel or carbon on the intake valve throat.
- ▣ Part of the VE calculation is the amount of air going in, AVF – Actual Volumetric Flow Rate, and if there is an intake restriction before the throttle plate, atmospheric high pressure air will be blocked, limiting the air needed to overcome the low pressure area behind the throttle plate.
  
- ▣ Perform the following test for verification.
  - ▣ MAF

# *MAF Test*

- ❑ KOEO the MAF sensor should read 0.0 GPS
- ❑ KOER, idle and at operating temperature MAF should read 2 to 7 GPS
- ❑ Slowly increase engine RPM and MAF value should rise
- ❑ At 2500 RPM the MAF should read 15 to 25 GPS or 2k to 3k Hz
- ❑ If the MAF is below specification there is a possible intake restriction



# VE Diagnostics

## Exhaust Restriction

- ▣ VE low
- ▣ STFT normal or slightly negative
- ▣ Exhaust restriction
  - ▣ Plugged Catalytic Converter
  - ▣ Carbon on the exhaust valve throat.
- ▣ Proper VE requires the air to exhaust out, if there is an exhaust restriction the volume of air required for the engine to create sufficient power will not be able to enter.
  
- ▣ Perform the following test for verification:
  - ▣ Catalyst Test



# Catalyst Test

- ❑ To test for a plugged Catalytic Converter, highlight and graph MAP Voltage
- ❑ With the engine running at 2000 RPM for 3 minutes note what MAP Voltage is, it should be around 1.2 to 1.6 Volts
- ❑ Snap the throttle to wide open from 2000 RPM
- ❑ MAP Voltage will rise from 2000 RPM at wide open throttle to approximately 3.8 to 4.2 Volts
- ❑ When the engine returns to idle, MAP Voltage should return to 1.2 to 1.6 Volts in less than 3 seconds
- ❑ If it takes longer than 3 seconds the Catalytic Converter may be plugged



# Thank you & Good Diagnosing



**3925 ADS 325**



**3970 ADS 625**