AUTOMOTIVE TECHNICIAN TRAINING SERVICES

Presents

Engine and Emissions Driveability Diagnostics
Part 2

1

Your Instructor For This Class

"G" Jerry Truglia

- **National Trainer, ASE World Class, Master: Auto, Truck, School Bus, L1, L3, CNG and…**
- **ATTP Master Instructor, New York State, CT and New Jersey**
- **STS (Service Technician Society) 2003 President**
- **TST (Technicians Service Training) Founder and President**
- **Author / Co Author/ Technical adviser on 25 plus books including OBD II and Mode 6, and Understanding and Diagnosing Hybrid Vehicles**
- **Published articles for multiple newsletters, and magazines**
- **Picked as one of the Top Instructors in the country by EPA & SAE**
- **Numerous Radio, TV, Internet, and SAE Video appearances**
- **PTEN, MotorAge and TST Webcast Instructor**
- **Motor Magazine Top 20 award winner**
- **Provider of OBD II Training for 13 states, Ontario Canada and the US EPA**
- **Guest speaker at SAE Congress, IM Solutions and Clean Air Conference**

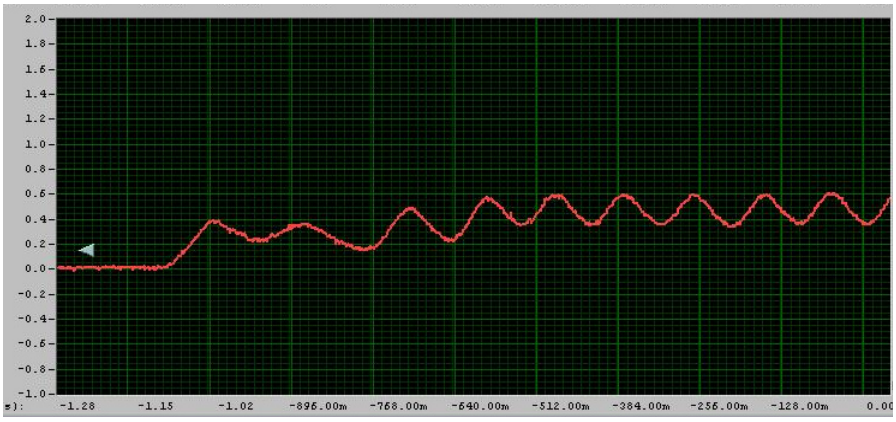
2

Engine Cranking Vacuum

Check engine cranking vacuum – 3 to 5 in (bouncing needle) indicates that the valves are opening and closing.

3

Pressure Transducers



The scope above is displaying a cranking vacuum waveform. The ramping waveform are pressure pulses from inside the intake manifold. The waves have a consistent general shape and amplitude, indicating good cranking vacuum on a good engine.

4

Engine Vacuum

Altitude Effect on Vacuum In Inches

Sea Level to
1000 ft .= 18 to 22
1001 ft. to 2000 ft. = 17 to 21
2001 ft. to 3000 ft. = 16 to 20
3001 ft. to 4000 ft. = 15 to 19
4001 ft. to 5000 ft. = 14 to 18
5001 ft. to 6000 ft. = 13 to 17
6001 ft. to 7000 ft. = 12 to 16

Readiness Monitor Drive Patterns: EVAP Monitors (Continued)	Drive Pattern Preconditions
	The monitor will not run unless:
	• MIL is OFF. • Fuel level is between 1/2 to 3/4 full. • Altitude is 7800 feet (2400 m) or less.* • ECT (Coolant Temp) is between 40F and 95F (4.4C – 35C). • IAT (Intake Air) is between 40F and 95F (4.4C – 35C).* • Cold Soak Procedure has been completed. * For 2002 MY and later vehicles: The readiness test can be completed in cold ambient conditions (less than 40F / 4.4C) and/or at high altitudes (more than 7800 feet / 2400 m) if the complete drive pattern (including Cold Soak) is repeated a second time after cycling the ignition OFF.

University Toyota, Toyota Motor Sales USA, Inc

The higher the altitude the lower the vacuum.
1 in of vacuum per 1000 feet
Note: Most vehicle Monitors will NOT be READY if altitude is above 7800 ft.

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Quick Engine Vacuum Diagnosis

Normal

Leaking Intake or Late Valve Timing

Advanced Valve Timing

- **Valvetrain problem**
- **Retarded valve and ignition timing**
- **Exhaust restriction**
- **Poor combustion**

6

Compression Test Dry

- Cranking compression checks the cylinders ability to SEAL
- Insert compression gauge in specific cylinder
- Remove ONLY one spark plug at a time… WHY?
- Cranking speed should be at 200 to 250 rpm.
- Four to five needle bounces total: First bounce at least 50% of total: see the pictures below… NOTE: Some Engine's such as the 5.7 Hemi is ONLY 3 Needle Bounces


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Compression Test Wet

All cylinders should be within 15% of each other on the dry test. Our next step would be to add some oil to the cylinder and retest. Reading that rise indicate ring or taper problems.

8

Running Compression Test

- Running compression checks the cylinders ability to breath (Remove Schrader Valve)
- Insert compression gauge in specific cylinder
- Remove ONLY one spark plug at a time
- Start the engine … RPM about 500 to 700
- Normal idle running compression 50-75 psi (about half cranking compression total).
- Normal snap compression readings should be about 80% of cranking compression: see the pictures below…

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Running Compression Test - What Does It All Mean?

Normal idle (running) compression is 50 to 75 PSI.

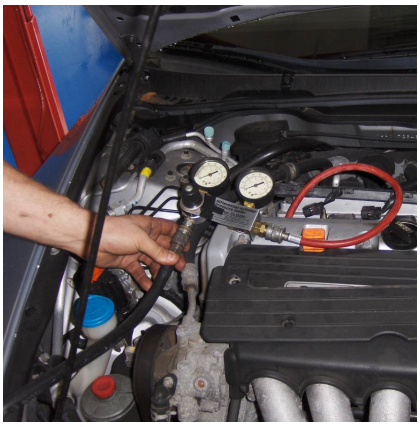
Snap reading lower than 80% of cranking compression indicates: restricted intake…possible carbon deposits, clogged intake, intake valve, worn cam lobe, rocker and or lifter problem.

Snap reading higher than 80% of cranking compression indicates: restricted exhaust…possible carbon deposits, clogged catalytic converter, exhaust valve, worn cam lobe, rocker and or lifter problem.

Example: Compression Cranking 125 psi x 80% Running = 100 psi.
Always compare cylinder readings before condemning any components.

10

Cylinder Leak Down Test



If compression does not come up during a wet test a Cylinder Leak Down Test needs to be performed.

11

Performing A Cylinder Leak Down Test

To perform a Cylinder Leak Down Test bring the cylinder being tested to top dead center (TDC).

Connect the tester to shop air and screw the tools output hose (make sure the Schrader valve is removed) into the spark plug hole.

Adjust the Leak Down tool to ZERO or adjust pressure to 100 psi (depends on the tool).

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Performing A Cylinder Leak Down Test

Block the intake open, remove the oil and radiator caps, then look at the tool and if there is a leak more than 15%, check for air coming out of the following.

If you hear air exiting the:
Intake = intake valve problem

Exhaust pipe = exhaust valve problem

Oil cap = ring problem and Radiator = headgasket, cylinder head or block.

You can also use a smoke machine and look for smoke coming out.

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Exhaust Backpressure

Good Exhaust Backpressure at idle should be 0 psi

More than ½ psi at idle = BAD

More than 1½ psi at 2500 = BAD

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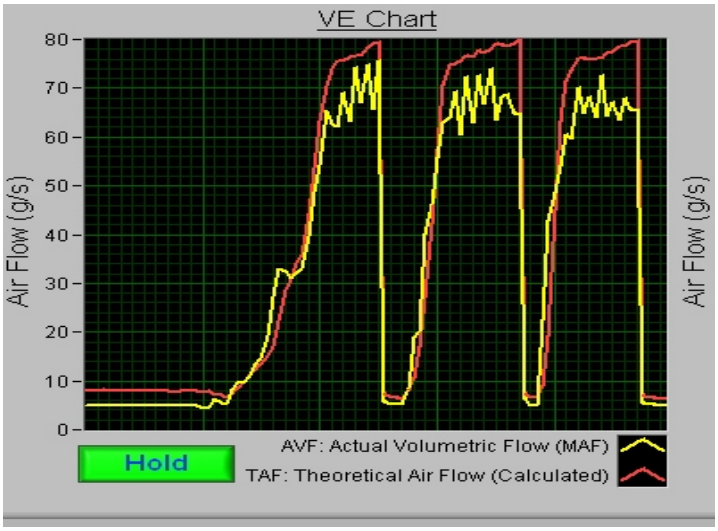
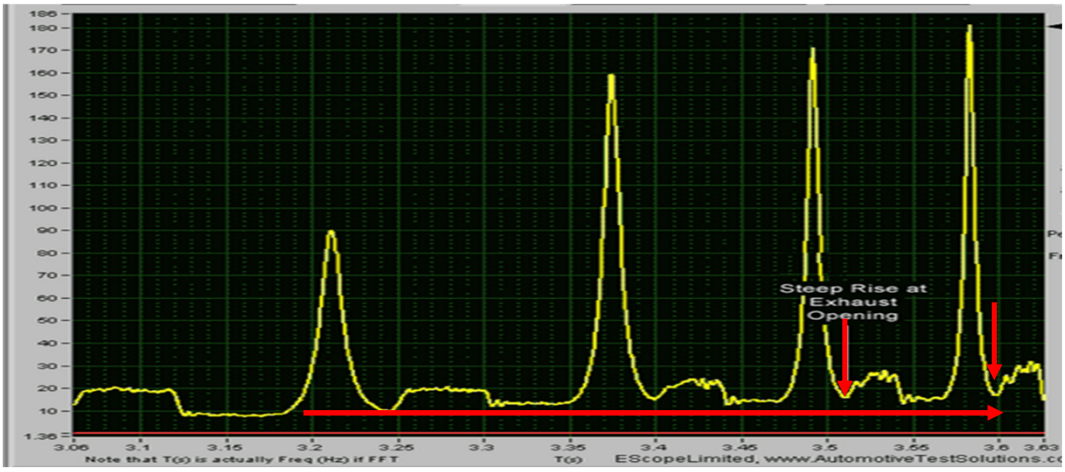
Exhaust Backpressure The Easy Way



15

Exhaust Backpressure The Easy Way



Take a look at the step rise in the exhaust valve opening that confirms a backpressure problem. This is all done without removing an O2, AF sensor or EGR valve.

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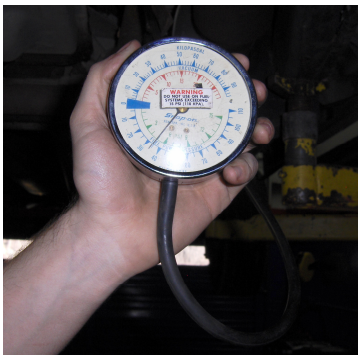
Diagnosing Exhaust Backpressure

A clogged catalytic converter can cause dramatic driveability issues. Aside from the feeling that the vehicle has no power when you drive it, you can check MAP sensor readings (or connect a vacuum gauge at the intake manifold) looking for a low vacuum reading. For backpressure testing, place the backpressure gauge in the Oxygen or Air Fuel sensor) for the following:

- **Good readings: 0 to 0.5 idle; 0.5 to 1.5 psi at 2,500 RPM**
- **Bad snap-throttle readings: 5 psi or more.**
- **If pressure gradually increases the longer the vehicle runs, this indicates an exhaust restriction**



Note: The picture to the right has 5 psi backpressure at idle

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Diagnosing Exhaust Backpressure

Note: Rising exhaust backpressure will decrease intake vacuum. You can accurately measure intake vacuum by looking at the MAP PID, increasing voltage reflects an exhaust restriction.

This can cause elevated CO, HC and NOx emission levels depending on the specific problem.

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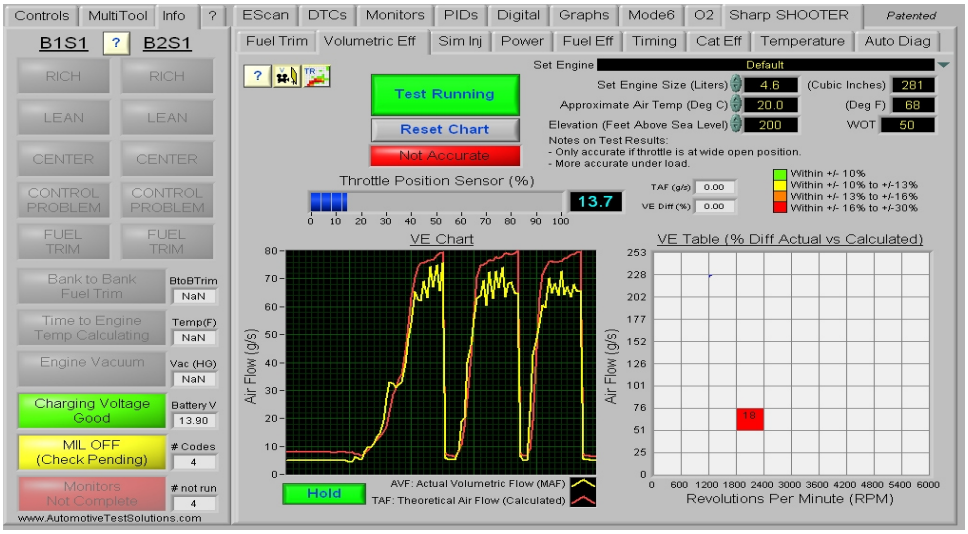
Diagnosing Exhaust Backpressure 2010 Ford F150 4.6L



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Diagnosing Exhaust Backpressure 2010 Ford F150 4.6L

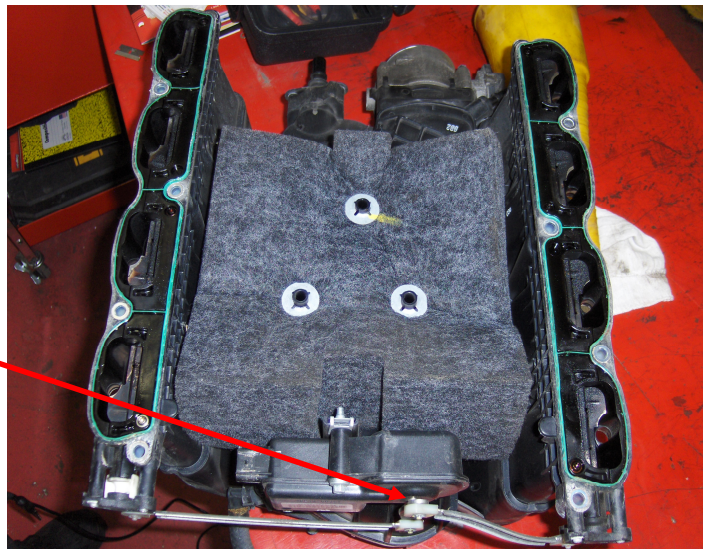
Confirming Back Pressure on Bank 2 Clogged Converter due to Intake Runner

20

Diagnosing Exhaust Backpressure 2010 Ford F150 4.6L

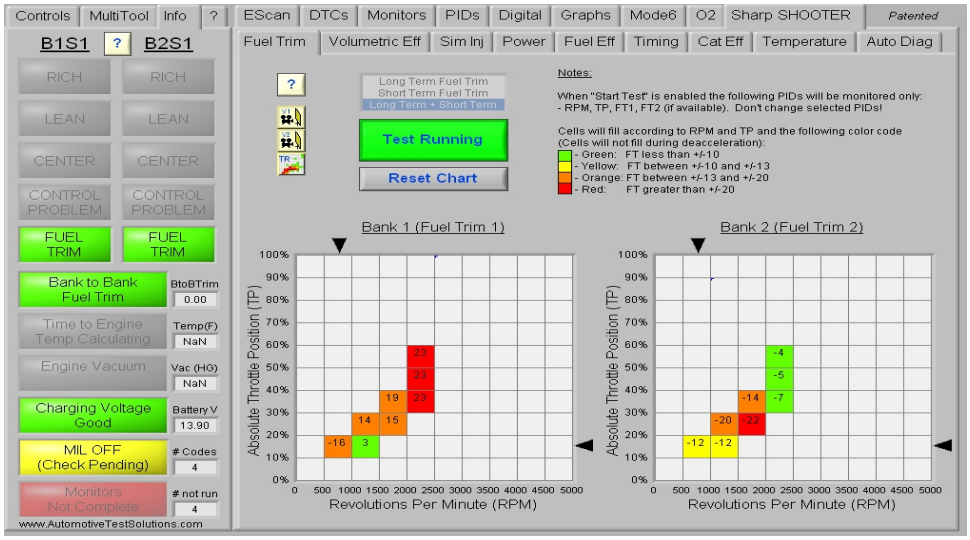
The Intake Runner rod clip was broken on Bank 2. This caused the intake flap to stay stuck closed.

Take a look at the Fuel Trim on the next slide.



21

Diagnosing Exhaust Backpressure 2010 Ford F150 4.6L



The Fuel Trim Reading on Bank 1 indicate a Lean Condition while Bank 2 Indicates a Rich condition.

Why?

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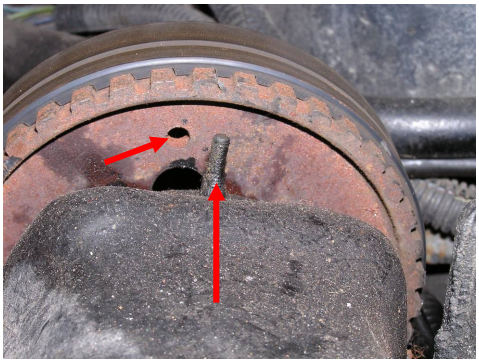
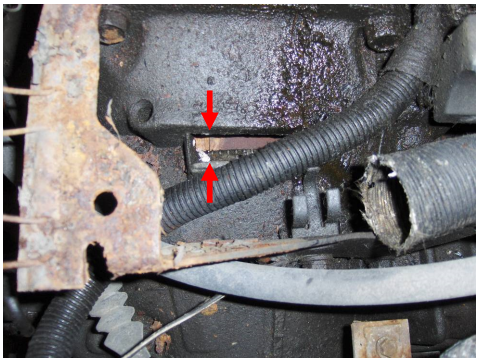
Timing Belt and Valve Timing Test



Cam Timing Belt Line Up Mark

Crankshaft Line Up Mark at TDC



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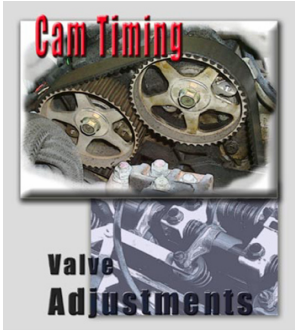
Engine Vacuum Low

Be sure to find and correct the cause. Don't overlook the possibility of a vacuum leak, wrong PCV or leaking EGR valve.

Ask yourself the following questions before dismissing the possibility that low engine vacuum is caused by something other than an engine mechanical issue:

Is the cam timing correct?
Is this true of both cams?
Is the exhaust restricted?

QUICK NOTE: Incorrect camshaft timing or improperly adjusted valves can both cause low engine vacuum and is often the culprit behind a Check Engine Light caused by a DTC P0108 - MAP circuit high.



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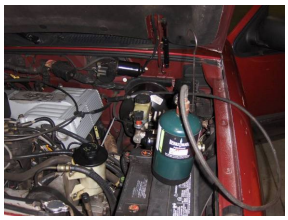
Five Minute No-Start Diagnostics

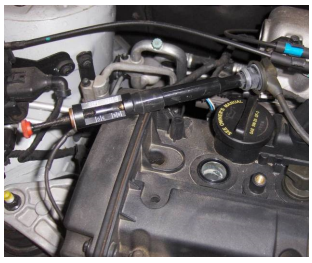
Air



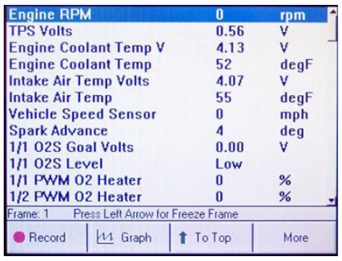
Fuel with propane or a Gas Analyzer

Good enough to start

NOT enough to start



Ignition Spark



RPM Check

Good Backpressure

25

2004 Lincoln Navigator 5.4L Engine Misfire / DTCs P0011, P0022

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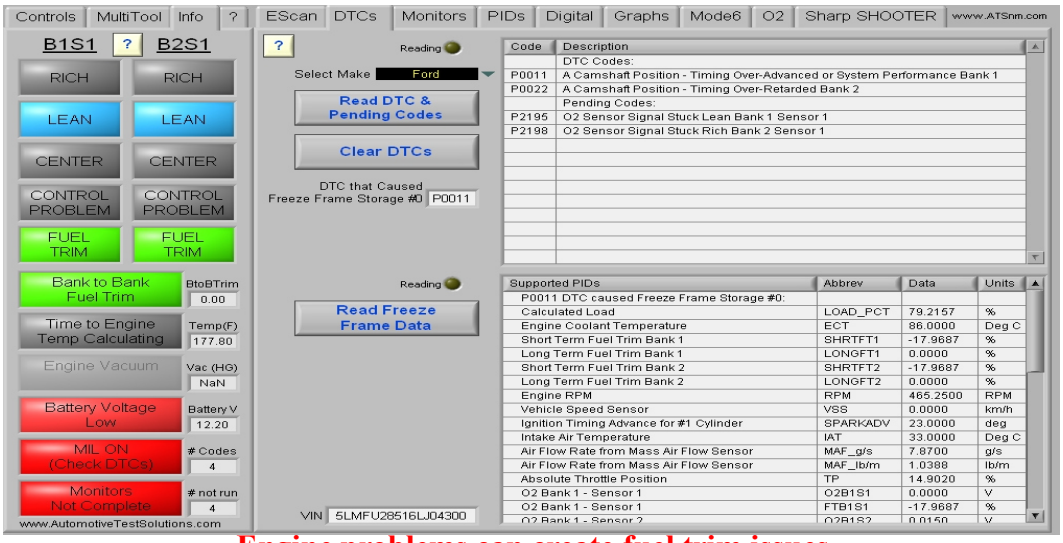
Making Sense Out Of DTC



Engine problems can create fuel trim issues

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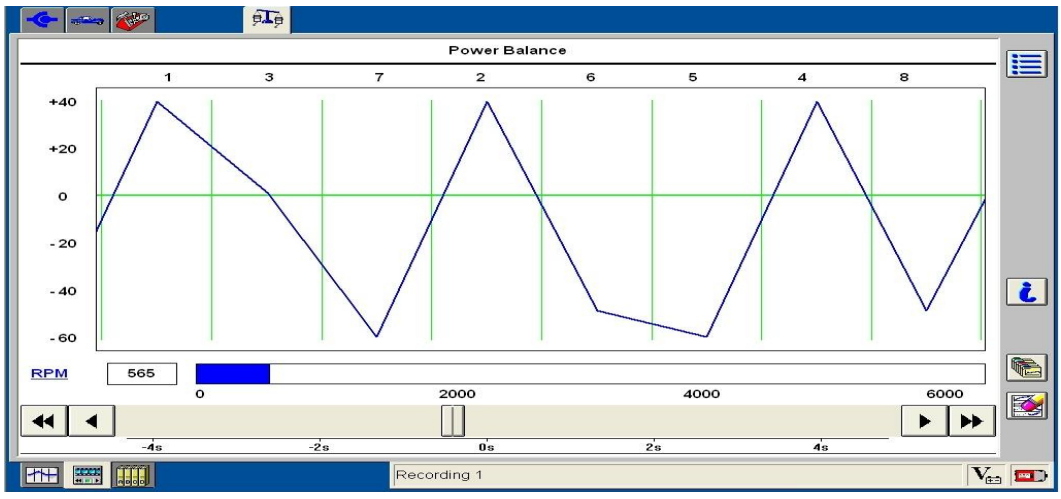
Ford Power Balance Test



Quick way to check for engine misfires…
Build a relationship with what you see, look at the firing order

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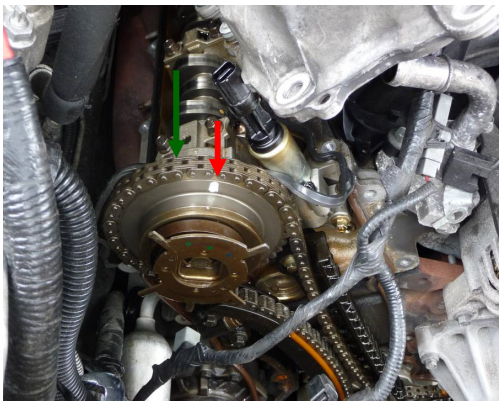
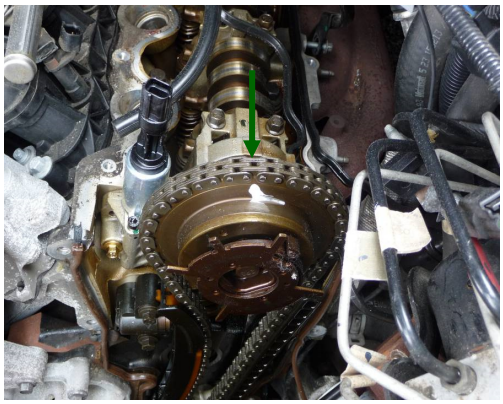
Mechanical Verification



Passenger side cam gear out of time



Driver side lines up correctly with crank keyway at 12:00

Notice how far off the cam is on cylinders 1, 2, 3 and 4 (passenger side)

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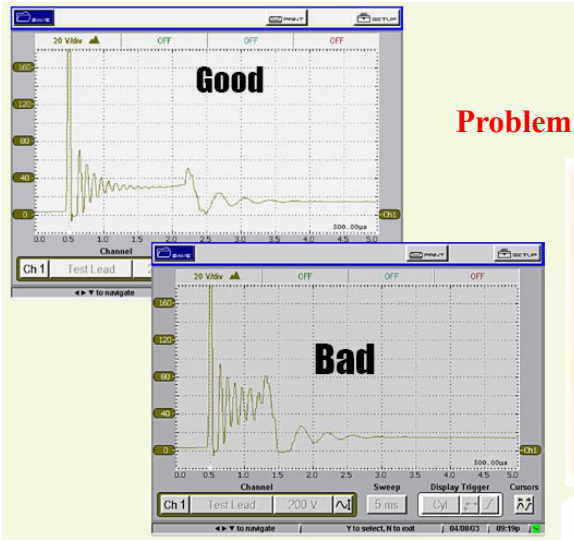
Checking Engine Mechanical Condition With An Ignition Scope

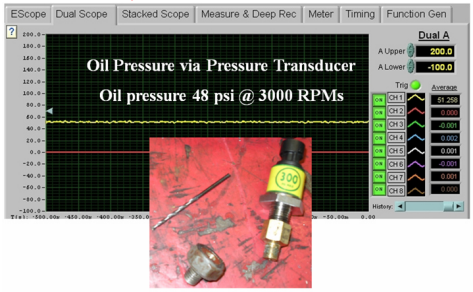


Problem That Was Discovered

30

2002 Honda CR-V Violent Engine Bucking (Engine Oil)

This case study is about a Honda that bucked violently when only warm. The technicians found that when the vehicle did this the PCM set a P1259, indicating a general VTec System Malfunction. The common causes for this problem are dirty or low engine oil, a plugged oil screen, a defective VTec solenoid, and a malfunctioning oil pressure switch.



Picture of a Pressure Transducer, drill bit and the old oil pressure switch (special threads), that had to be used to get the pressure reading.

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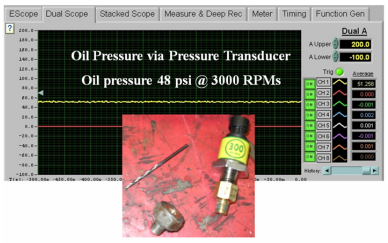
2002 Honda CR-V Violent Engine Bucking (Engine Oil)

The technicians decided to test the VTec solenoid using pressure transducers. They applied power to the solenoid, it adjusted timing accordingly. So, this ruled out a bad solenoid and confirmed good timing.

Hooking up a transducer to the oil pressure sending switch port indicated that there was 48 psi of pressure at that location, which met specifications and discounted a plugged oil screen.



32

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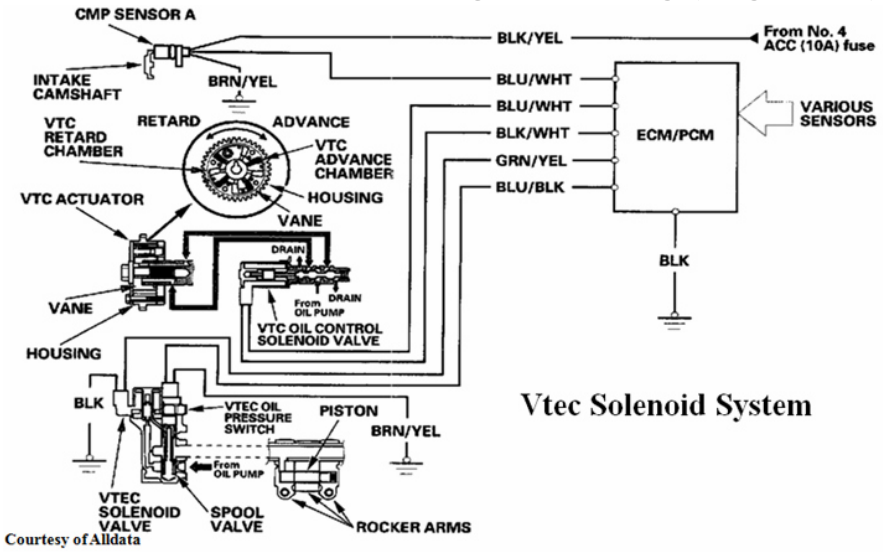

Vtec Solenoid System

Courtesy of Alldata

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2002 Honda CR-V Violent Engine Bucking (Engine Oil)

VTEC/VTC

- The i-VTEC has a VTC (Variable Valve Timing Control) mechanism on the intake camshaft in addition to the usual VTEC.
  This mechanism improves fuel efficiency and reduces exhaust emissions at all levels of engine speed, vehicle speed, and engine load.
- The VTEC mechanism changes the valve lift and timing by using more than one cam profile.
- The VTC changes the phase of the intake camshaft via oil pressure. It changes the intake valve timing continuously.

Image

VTC system

- The VTC system makes continuous intake valve timing changes based on operating conditions.
- Intake valve timing is optimized to allow the engine to produce maximum power.
- Cam angle is advanced to obtain the EGR effect and reduce pumping loss. The intake valve is closed quickly to reduce the entry of the air/fuel mixture into the intake port and improve the charging effect.
- Reduces the cam advance at idle, stabilizes combustion, and reduces engine speed.
- If a malfunction occurs, the VTC system control is disabled and the valve timing is fixed at the fully retarded position.

Image

Courtesy of Alldata

VTEC system

- The VTEC system changes the cam profile to correspond to the engine speed. It maximizes torque at low engine speed and output at high engine speed.
- The low lift cam is used at low engine speeds, and the high lift cam is used at high engine speeds.

34

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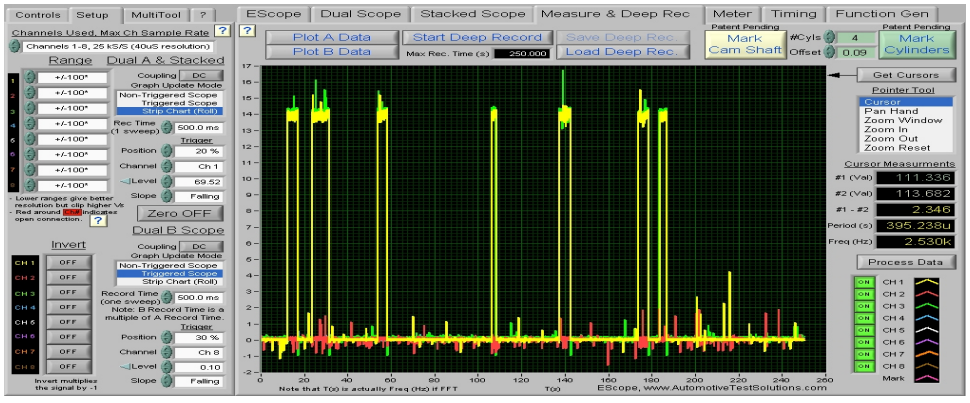
2002 Honda CR-V Violent Engine Bucking (Engine Oil)

Scope on VTec Solenoid and Oil Switch @ 700 RPMs After Fix



The above scope reading (yellow and green) are the signal from the VTec solenoid and the oil pressure switch (transducer voltage conversation).

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2002 Honda CR-V Violent Engine Bucking (Engine Oil)

Remember that your Brain-Ears-Eyes-Nose-Hands are the BEST tools—look at what the technicians found.

They called the customer and sure as heck, her son-in-law did the oil change, and used the incorrect weight motor oil! He used 10W30 instead of 5W20.

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2002 Honda CR-V Violent Engine Bucking (Engine Oil)

They figured that the thicker viscosity motor oil was plugging up the oil passages in the engine. After changing the motor oil they drove the vehicle after getting the engine warm, and the problem was gone!

Note: Honda Oil specification for this engine is 5w30HD

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2001 Mitsubishi Montero 3.0L No Start

Always check DTCs and TSBs, and do not forget to check the basics.

1. Make sure that the engine is turning the right way by observing that the exhaust is blowing instead of sucking.

2. Confirm whether the problem is spark, fuel, or mechanically related.

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2001 Mitsubishi Montero 3.0L No Start

3. Here is what we found:

Gas in the oil? We performed the burn test just to make sure. (Use a source of fire to check for a flame. Perform in a well ventilated area)

Worn spark plugs

Wet intake

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2001 Mitsubishi Montero 3.0L No Start

Cause: Leaky injectors fouled spark plugs & washed down the cylinders, decreasing compression.

Fix: Replaced the leaky injectors, changed the motor oil, filter, remove intake, cleaned excess fuel, squirted oil down the cylinders, and replaced spark plugs.

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Thank You !

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p. 845 628-1062
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