iEA™

Intelligent Engine Analyzer

Training

Hidden Pressure Hunt

James Garrido - Have Scanner Will Travel

This month we will use our in cylinder pressure transducer to take a look at a defect that many shops have trouble nailing down even by other more time consuming methods. This defect is a clogged catalyst on only ONE bank of a 2 bank engine equipped with a dual catalyst system.

When only one catalyst on one bank has become restricted the typical complaint is a lack of overall engine power. And if the restriction is severe enough miss firing on only one bank and not necessarily on the bank with the defect! This bank isolated miss fire is due to the effects on airflow through the engine with one side of the engine restricted. When one bank is flow restricted the result is less than 50% of the total air entering the engine ends up being passed through the restricted bank. Yet 50% of the fuel mass is still delivered via the injectors to that restricted bank. As a result one bank ends up very lean and the other bank over rich. The first telling sign of an unequal airflow due to restriction on a V-type engine are the fuel trims. If the fuel trims are moving in increasingly opposite directions bank to bank as engine speed and load increase you need to check for a restriction.

Figure 1 is a P0300 Failure Record captured on code set from a 2003 Chevrolet pick up with a 4.8L cam in block V8. Notice the fuel trims in the capture. Bank one is the side with the clogged catalyst and as such has a negative total fuel trim (STFT+LTFT) correction of -21% while bank 2 is showing a positive total fuel trim correction of +25%.

DTC Code3of4

P0300 Failure Record Engine Misfire Detected
Last Test: Passed / Passed & Failed / History — This Ignition: Passed / MIL Requested

Short Term FT Bank 1	-7	%	Inj. PWM Average Bank 1	6.2	ms
Long Term FT Bank 1	-14	%	Inj. PWM Average Bank 2	10.0	ms
Short Term FT Bank 2	9	%	TP Indicated Angle	42	%
Long Term FT Bank 2	16	%	Engine Load	34	%

Engine Speed	3156	RPM	Short Term FT Bank 2	9	%
Desired Idle Speed	525	RPM	Long Term FT Bank 2	16	%
ECT Sensor	195	°F	Inj. PWM Average Bank 1	6.2	ms
Start Up ECT	165	°F	Inj. PWM Average Bank 2	10.0	ms
APP Average	30		Air Fuel Ratio	14.6	: 1
APP Indicated Angle	41	%	Traction Control	Inactive	
TP Desired Angle	42	%	TCC/CC Brake Switch	Released	
TP Indicated Angle	42	%	Transmission Range	Drive 4	
Fuel Tank Pressure Sensor	1.5	Volts	Current Gear	3	
Powertrain Induced Chassis Pitch Command	Inactive		Transmission OSS	1893	RPM
Engine Load	34	%	TCC PWM Solenoid Command	On	
BARO	98	kPa	Vehicle Speed Sensor	47	mph
BARO	4.65	Volts	Engine Run Time	00:01:59	
MAP Sensor	89	kPa	Not Run Counter	1	
MAP Sensor	4.21	Volts	Fail Counter	7	
MAF Sensor	75.47	g/s	Pass Counter	4	
Loop Status	Closed Loop		Mileage Since First Failure	93	miles
Short Term FT Bank 1	-7	%	Mileage Since Last Failure	3	miles

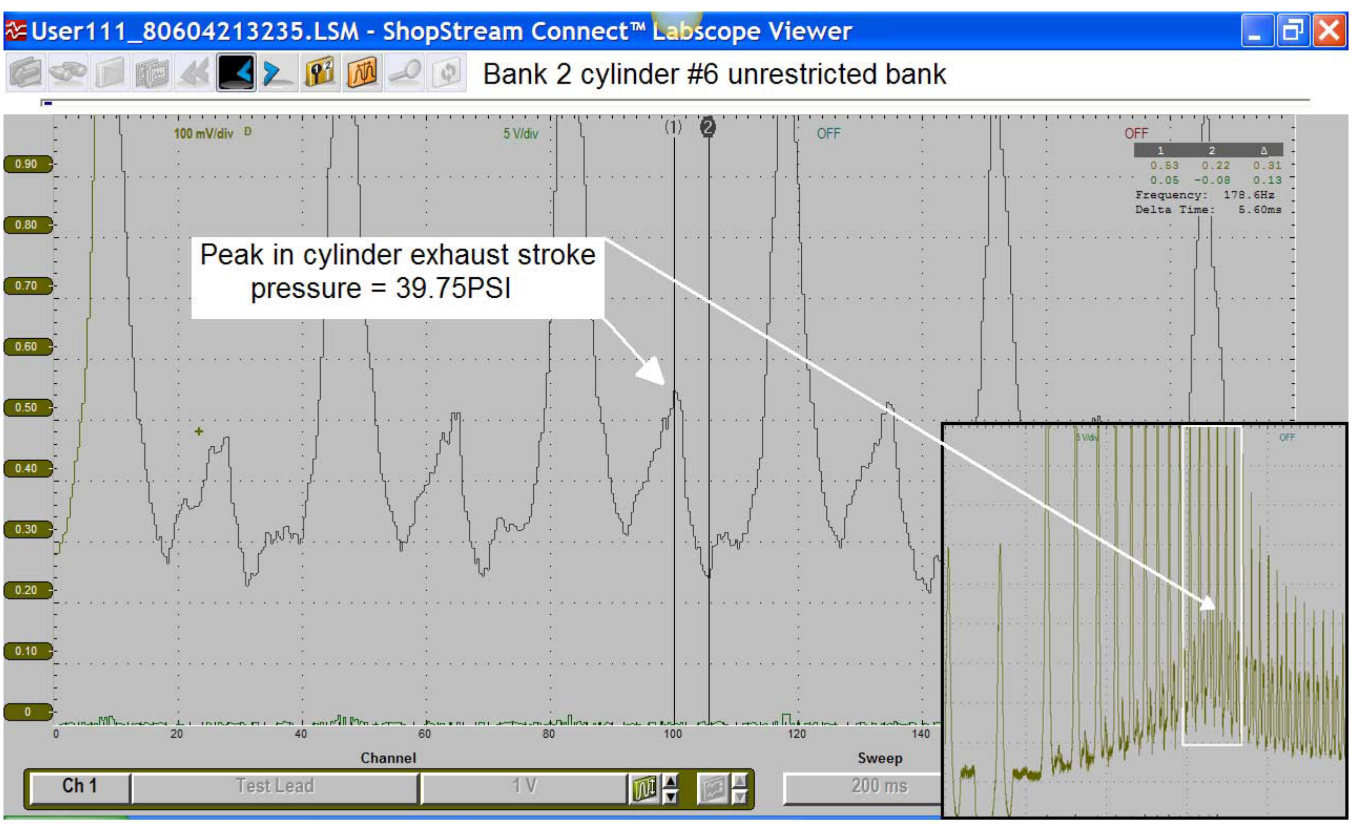
fig. 1 P0300 Failure Record

How would you diagnose this condition to be a clogged exhaust before purchasing that expensive catalyst? Drop the exhaust and test drive with an open system? And risk needless broken bolts, not a great idea in the rust belt states. A vacuum gauge reading at idle and 2500 RPMs is only useful on severely restricted catalyst systems and will not show a partial restriction on only one bank. You could install a back pressure gauge in place of the front oxygen sensor and then power brake the engine under load at a specific RPM. Then move the back pressure gauge to the other side and compare at the same load. My experience with this is unless the catalyst is severely restricted the gauge bounces around so quickly it is difficult to see if the average needle movement is higher side to side. Pulling hard to get at O2 sensors on a hot engine is no picnic either.

I prefer removing one spark plug from each bank in turn and installing a pressure transducer. Then look at the saved pressure waveforms so that you can get an easily acquired and highly accurate comparison of in cylinder conditions bank to bank.

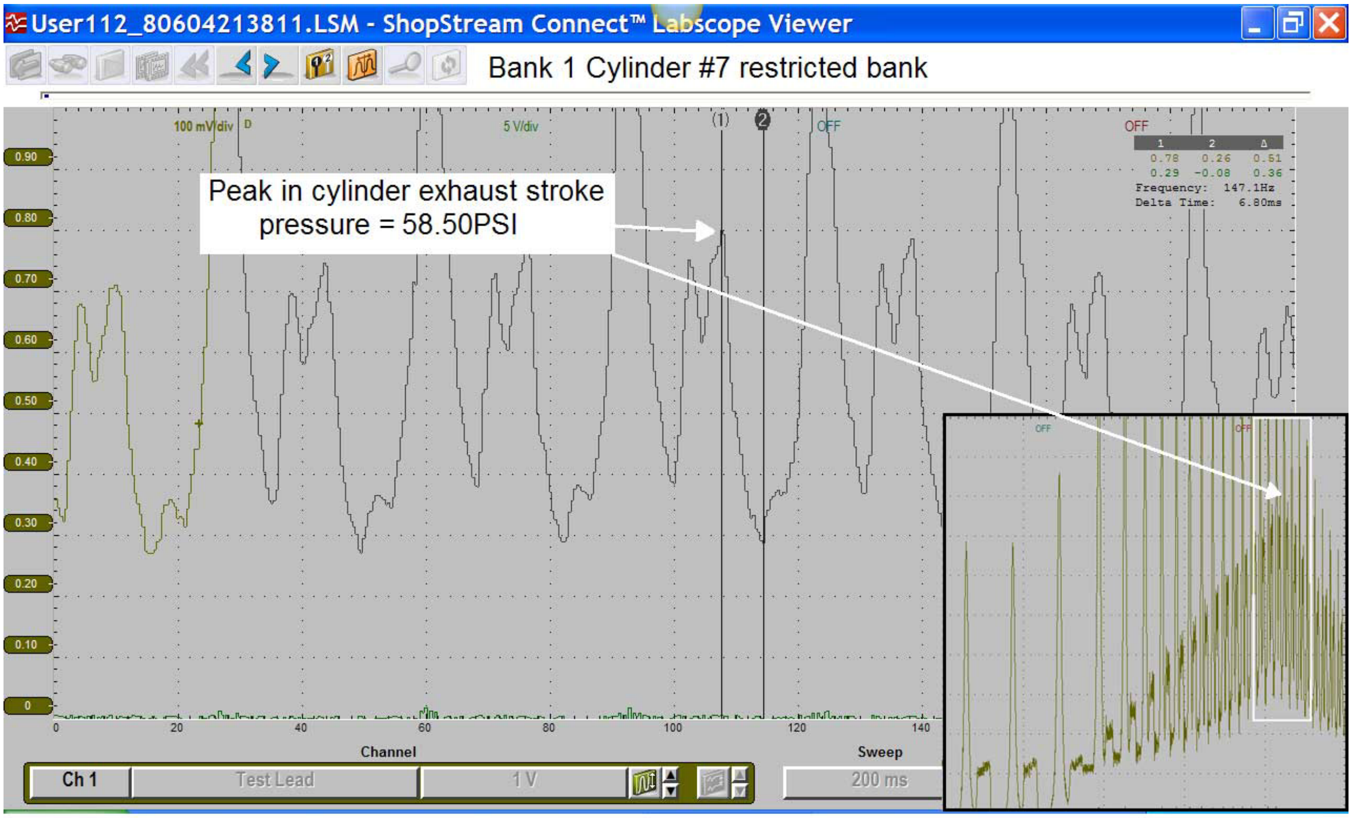
To do this test start at idle speed so that you have a relatively slow crankshaft speed and a plenty of engine vacuum. Then snap the throttle open. The engine vacuum drops as outside air rushes in to fill the low pressure area in the intake. Initially the crankshaft has not yet begun to spin faster so the extra air has lots of time to fill the cylinders before it attempts to exit the exhaust ports.

In figure 2 I have captured bank 2, cylinder 6, the good side of this engine. Compare these pressures waves seen from the good side to the clogged bank 1, cylinder 7 shown in figure 3. In the zoomed out capture shown in the lower right corner of the images you can see that the cylinder from the restricted bank built up more pressure on average than the cylinder from the unrestricted bank.



Bank 2 cylinder #6 - Unrestricted Bank

fig. 2



Bank 1 Cylinder #7 - Restricted Bank

fig. 3

If we zoom in on the highest in cylinder pressure peak section of the wave we can actually see the cycle by cycle difference between the cylinders on the different banks. On the bad cylinder you can see that the end of the exhaust stroke pressure wave plateau peaks at a high of 0.78V even after the pressure drops slightly as the intake valve opens during the overlap period. On the good cylinder you can see the exhaust stroke pressure wave plateau peaks at only 0.53V and then permanently drops off as the intake valve opens during the overlap period. The scaling on this sensor is 1.0V = 75 PSI so the variation between the restricted and unrestricted cylinders is 0.25V or 18.75 PSI! It is impossible to get this kind of accuracy and detail using older methods for testing for back pressure. Even a slightly clogged catalyst will show up by using in cylinder pressure measurements.